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ABSTRACT

The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC) helps teachers by offering a broad assortment of services to enable them to quickly locate educational resources. This theme issue of the serial "ENC Focus" is designed to give educators information on curriculum resources available for teaching math and science in K-12 classrooms. This issue is organized around the theme of mathematics and science literacy. Articles include: (1) "Literate--and Safe--on the World Wide Web" (Kimberly S. Roempler); (2) "Gender Equitable Schools: They Benefit Everyone" (Sundra Flansburg); (3) "Ohio Resource Center for Mathematics, Science, and Reading" (Peggy Kasten); (4) "Dear Mrs. B., Please Reconsider..." (Lynn Bradley and Joanne Caniglia); (5) "Mathematics and Science Literacy for All Americans" (Frank X. Sutman); (6) "Innumerate and Proud of It" (Mark Holtman); (7) "It's about Relevancy" (Carol Damian); (8) "The Proving Ground for History" (David O'Connell); (9) "Talking Their Way to the Middle of All Numbers" (Kristine Reed Woleck); (10) "Graphing Savvy: Giving Students a Sense of Mathematical Power" (Sue McMillen); (11) "Improving Literacy through Innovative Professional Development for Teachers" (Mary Hindelang); (12) "Ecosystem Succession" (John Rosemurgy); (13) "The Life and Times of a Bean Plant" (Tom Sprague); (14) "A Vote for Fidel Castro Is Not Truely a Vote against Alison Peebles" (Alison Peebles); (15) "Media Literacy: Yes, It Fits in Math and Science Classrooms" (Frank Baker); (16) "Math and Science Illiteracy in the News" (Carolyn Hamilton); (17) "Cloning and the Media: A Snapshot of Scientific Literacy" (Lynda Titterington and Suzanne Drummer); (18) "Math on the Map" (Wendy Cheely); and (19) "Putting Textbooks to the Test" (Jo Ellen Roseman, Gerald Kulm, and Susan Shuttleworth). (ASK)

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A Magazine for Classroom Innovators

Volume 8, Number 3, 2001

Becoming Literate in Mathematics and Science

The knowledge and skills to handle the ever-changing world with confidence.

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The Mission of the Eisenhower National Clearinghouse

is to identify effective curriculum resources, create high-quality professional development materials, and disseminate useful information and products to improve K–12 mathematics and science teaching and learning.

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Provides the best selection of math and science education resources on the Internet.

Supports teachers' professional development in math, science, and the effective use of technology.

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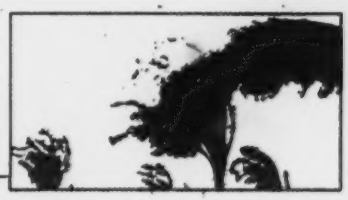

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After our students leave formal schooling, they, like us, will learn about scientific breakthroughs from popular news sources. This survey looked at the implications.

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Combining math with writing and social studies can help students attain a higher level of literacy in all three areas.

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Project 2061's evaluation of textbooks identifies features that help all students learn the ideas and skills that make up mathematics and science literacy.

Look for this icon throughout the magazine. It invites you to access the Internet for more information, more resources, more ideas for your own classroom innovations. The electronic version of this publication will help you get started. Visit enc.org/focus/literacy

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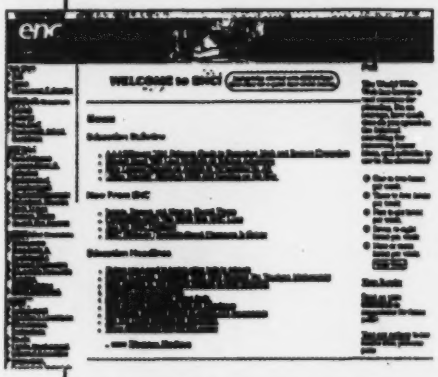

See page 11 for information about ENC's web site: enc.org

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Update ...

Around the Clearinghouse and the Nation

This section features columns, essays, and news of interest to classroom innovators.

What is Eisenhower National Clearinghouse?

Funded through a contract with the Office of Educational Research and Improvement of the U.S. Department of Education, ENC was created in 1992 to collect and catalog curriculum resources for K-12 mathematics and science educators and to disseminate information about federally funded educational programs. Our products and services have evolved to include a web site, ENC Online (enc.org); *ENC Focus*, a free quarterly magazine; and numerous other publications and services. For more information on ENC's vast collection of curriculum resources, see page 40.

Editorial

I can balance my checkbook!

Statistics don't confuse me!

My favorite reading is anything about science!

Or, Some Things We All Want to Hear

by Carolyn Hamilton, ENC Publications

If we define the literate person as having knowledge or competence in a subject, we're all illiterates sometime and someplace. Our illiteracies can handicap us in important matters and be minor irritations in others.

As a visual illiterate, I can be baffled and intimidated when I'm told that the jarring jumble of colors and lines in one painting makes it more important and valuable than the appealing picture of a clown by the same painter. I'll remember not to give my opinion again within the earshot of strangers.

As a math illiterate, my eyes glaze over when my new employer rattles off deductions, withholdings, grosses, and nets on the paycheck statement. The numbers on my first paycheck are a disappointing surprise. Life is full of surprises like that.

As a science illiterate, I do not expect to comprehend my doctor's long explanation of her findings. What's sodium? Where in my body would I find it? Dare I ask? If I do, will I understand the answer?

All of us who were teaching 20 years ago have been computer illiterates. We became literate because we had to.

There are some literacies we must have for our own good as individuals and as a nation. Around the world, math and science literacy is now seen as a "must-have" for young people in industrialized nations. Schools must prepare young people to be math literate, science literate, and technology literate. We take part in international studies to determine how well we are teaching these literacies in comparison with the rest of the world.

What might a literate high school graduate look like? She would have confidence in her ability to understand net gains and losses, spreadsheets, and annual reports. He would know the composition of matter and how the chem-

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istry of the universe affects the decisions we make in our personal and community life. Both would look back at their math and science classes as days of growing self-confidence and discovery. They would never need to apologize for shortcomings in their basic math and science competencies. They would accept as a matter of course their responsibility to understand the world around them.

In this issue, teachers, teachers of teachers, and even a student or two look at this multifaceted topic, Becoming Literate in Mathematics and Science. You'll find thoughts on the meaning and importance of mathematics and science literacy from the likes of Nobel Laureate Leon Lederman (page 23), internationally known mathematician John Allen Paulos (page 24), and distinguished science education leader Frank Sutman (page 20).

In a talk with a group of high school students, ENC science education specialist Carol Damian found that young people have some interesting ideas on the meaning of the topic, too (page 25). The students' basic question—Why do I have to learn this?—is addressed in poet David O'Connell's article on how Thomas Kuhn's groundbreaking book *The Structure of Scientific Revolutions* changed the way he viewed science (page 26).

Since media literacy has such a profound impact on mathematics and science learning for most Americans, this issue explores the subject from several different perspectives. Kim Roempler, ENC Associate Director of Instructional Resources, devotes her regular column, Using the Internet, to the concerns teachers and parents have when youngsters turn to the web for information (page 6). From the realm of public television comes Frank Baker with specific advice for teachers (page 48). Lynda Titterington and Suzanne Drummer examine how well the media explained the science behind cloning and how much adults learned and retained (page 51).

As in every issue of *ENC Focus*, most articles deal with classroom practice, and it is clear that literacy is a paramount concern for teachers on every level.

Kindergarten teacher Tom Sprague introduces scientific inquiry (page 42), and first-grade teacher Kristine Woleck lets her students tell how they "talked their way to the middle of all numbers" (page 29). Fourth-grade teacher Wendy Cheely shows how her students learn to understand mathematics through writing (page 54).

Ways to tap into visual literacy skills are described by middle school science teacher John Rosmurgy (page 39) and mathematics educator Sue McMillen (page 32). High school student Alison Peebles shows how she applies her growing mathematics literacy to understand the way democracy works (page 45).

Promoting mathematics and science literacy is the daily work here at ENC. For that reason we're delighted to announce the launch of a new feature called Classroom Calendar on our web site (enc.org).

Hundreds of resources will be grouped around themes and ideas for classroom instruction. The ENC staff believes, as you do, that math and science classes can be engaging, fun, and connected to the world around us. Days, weeks, and even months will be a cause for learning and celebration at this area of ENC Online. Read about Classroom Calendar on page 19, and of course click on enc.org for your own enjoyment.

Please remember that we always welcome your comments and suggestions. Let us know when you agree or disagree with our editorial statements or policies and the articles we publish.

Carolyn Hamilton is manuscript editor and news writer for ENC. A veteran journalist, she has written about educational issues for school library media specialists and school board members. Email: chamilton@enc.org

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ENC helps readers to continue online

Join in the Dialogue! Write for *ENC Focus*

Topics and Deadlines:

Mathematics and Science Across the Curriculum - Submissions due September 1, 2001

Increasing Your Mathematics and Science Content Knowledge - Submissions due December 1, 2001

Success in the Urban Classroom - Submissions due March 1, 2002

Topics and deadlines subject to change without notice.

See Writers' Guidelines on page 8.

Literate—and Safe—on the World Wide Web

True Internet literacy goes beyond teaching students how to navigate the web. As we give our children the freedom they need to become web literate, how can we keep them safe?

by Kimberly S. Roempler,
ENC Instructional Resources

It took me a while to make the decision, but I finally got high-speed Internet access at home. My nine-year-old daughter Kelly had been bugging me to replace our slow computer and phone-line Internet access with the stuff she has at school—bright blue and fast! I bought her a see-through blue iMac and a mouse with a red light that looks like a laser.

According to Kelly, the blueness, see-throughness, and "laser" were the selling points. The cable modem hook-up guarantees instant access to the Internet at any time of the day. Of course, those details have nothing to do with Kelly's Internet literacy. That is a job for her teachers and me.

True Internet literacy goes beyond teaching youngsters how to navigate the web. We also must help them learn to choose wisely from the almost infinite amount of information that can be found on the monster that is the World Wide Web. Thinking of it that way brings up a very important, related issue: As we give our children the freedom they need to become web literate, how can we keep them safe?

Information Literacy

As part of its Nine Information Literacy Standards for Student Learning (www.ala.org /aasl/ip_nine.html), the American Association of School Librarians writes that students who are information literate:

- access information efficiently and effectively;
- evaluate information critically and competently; and
- use information accurately and creatively.

We all need information literacy skills to help us judge the value and the truth of the information we receive whether it is through books, magazines, newspapers, television, radio, or the Internet. Children and teenagers need these skills because they spend enormous amounts of time attending to media messages. Without guidance, youngsters may not realize why the message was created or how the message-maker intends to influence them.

I have found two excellent web resources to help teachers and parents provide that guidance. The Cable in the Classroom web site (www.ciconline.com) focuses directly on the issues teachers face. WebSmartKids.org (www.websmartkids.org) is aimed at parents, but the site provides food for thought for teachers as well. It is also a valuable resource for teachers who want to help parents guide their children's Internet use at home.

Both Cable in the Classroom and WebSmartKids.org gave *ENC Focus* permission to print excerpts from the advice they provide online. We encourage you to visit each site, and the sites listed in the box below, for more information.

Advice from Cable in the Classroom www.ciconline.com

Typing a keyword in a search engine can easily result in more than 50,000 hits. With so much data at their fingertips, how do youngsters decide which web sites provide accurate information for a school report or when they are just browsing at home? Cable in the Classroom recommends teaching students to ask the five Ws: Who? What? When? Where? and Why?

Who is the site's author? If the information sounds authoritative, children have a tendency to assume it's true. But anyone can create a web page. Have students look for links to the author's biographical information to evaluate that person's credibility.

What is the site's purpose? What is it trying to do—sell products or services? Present information? Advocate ideas? Entertain? Is it ad-supported or sponsored by an

Roempler's Recommended Resources

WebSmartKids.org - A Parent's Guide to Building Children's Media Literacy Skills for the Internet
(www.websmartkids.org)

Children's Partnership with the National PTA and the National Urban League--Parent's Guide to the Information Superhighway
(www.childrenspartnership.org)

organization that is trying to exert influence in some way? Make sure students understand that the purpose of a web site may not be obvious.

When was the web site last updated? If it hasn't been maintained, the data may no longer be accurate. Does the information agree with other sources on the web or in print?

Where does the site originate? Because of the global nature of the web, you may want to dissect the web address (Uniform Resource Locator or URL) or search for an address through the internal links to determine the country or organization of origin. Nationality may or may not have some bearing on the message.

Why does the site exist? Designing a personal home, hobby, or class page can illustrate the editorial thinking that goes into presenting information on the web. It reminds students to think critically about the motivations that can influence the messages they find on the web.

Advice from WebSmartKids www.websmartkids.org

As mentioned earlier, WebSmartKids.org addresses its advice primarily to parents, but teachers can adapt the recommendations for classroom use. Articles and resources mentioned can be accessed directly from the site.

How much time does your child spend online each day?

Adult involvement is the key to responsible web behavior and to the development of information literacy skills for the Internet. Put the computer children use in an area of the house that everyone shares. (In the classroom, make sure that monitor screens can be seen from other parts of the room.) Communicate to youngsters that you're interested in their computer-using habits.

With whom does your child communicate online?

The anonymity of the online world, combined with its interactive nature, makes children vulnerable. Explain to your child that you will monitor Internet use and Internet friendships.

What are your child's favorite places on the web? What sites has your child bookmarked?

If you want to help your child visit useful, reliable, interesting sites, visit such sites together. You could even begin a family (or classroom) email newsletter by sending your child an email message each week with a description of an excellent site you've discovered that you think your child will enjoy.

Is your child able to tell from the URL the site's title or sponsor? Both are clues to whether the information at a site is reliable or valuable.

Literacy begins with the basics: to be literate in print, children must learn which way to hold a book, where (and what) the title is, and the meaning of authorship. Information literacy on the Internet includes such basic skills as learning how to tell who hosts the site, who wrote the site, and when the site was last updated.

Does your child follow the teacher's and school's guidelines about using online information or services to complete homework?

Many schools use their own web sites to post these guidelines. If you and your child are not sure about your school's policy governing Internet use, be sure to find out. If your school doesn't have such guidelines, volunteer to head a committee to create them!

Does your child understand copyright rules for online information?

Review the rules for attributing online information with your child by reading "Right and Wrong Online: Teaching Your Children Ethics in Cyberspace" in

US Department of Justice – Rules of the Road: Internet Do's and Don'ts
(www.usdoj.gov/kidspage/do-dont/kidinternet.htm)

American Association of School Librarians—The Nine Information Literacy Standards for Student Learning
(www.ala.org/aasl/ip_nine.html)

SafeKids.com – Family Contract for Online Safety
(www.safekids.com/contract.htm)

GetNetWise.org – Online Safety Guide: Safety Guidelines by Age Group
(www.getnetwise.org/safetyguide)

US Department of Justice FBI – A Parent's Guide to Internet Safety
(www.fbi.gov/publications/pguide/pguidee.htm)

National PTA – Technology Safety Position Statement
(www.pta.org/programs/techsafe.htm)

National PTA – Keeping Your Child Safe Online
(www.pta.org/programs/ftonline.htm)

US Department of Education – Parent's Guide to the Internet
(www.ed.gov/pubs/parents/internet)

Northwest Educational Technology Consortium (NETC) Acceptable Use Policies
(www.netc.org/tech_plans/aup.html)

Internet in the Classroom
(enc.org/professional/timesavers/classroom)

Browsers for Kids
(www.getnetwise.org/tools/index.php3?definition=kidbrowsers)

The Internet in the Community
(www.getnetwise.org/tools/community.shtml)

The Parent's Guide to the Information Superhighway (www.childrenspartnership.org).

Does your child know what to do when he or she encounters sexually explicit, violent, or hate-based content on a web site?

Prepare your child for undesirable sites by discussing the existence of the sites before your child ever sees one. Discuss why people put such content on the Internet, and what children should do if they come across the content, such as leave the site, tell or show a parent, and then report the site. Go to the WebSmartKids site to report offensive sites via links to the National Center for Missing or Exploited Children's CyberTipline, or to the FBI's field office in your community, or to your state police. The GetNetWise site has links to state police headquarters.

Does your child know how to use the Internet safely—how to protect privacy and report upsetting content?

Teach your child to use the Internet safely. Discuss the rules for safe surfing and post them near your family or classroom computer. Think about the places where children have access to the Internet. What are the child safety policies at each of these places? Make sure children understand the rules and know how to follow them in each situation.

Taking this Advice at School and at Home

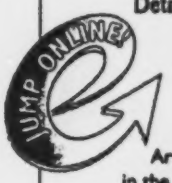
Kelly and I have spent a tremendous amount of time together browsing many of the sites listed in Roempler's Recommended Resources (see pages 6 and 7) and talking about what sites are appropriate for her and why. For now, I have limited her Internet search engine to Ask Jeeves for Kids (www.ajkids.com) and her browsing to Yahooligans! (www.yahooligans.com). She has a list of sites that she is able to visit without me sitting down beside her—they are all in her Bookmarks folder for easy access. I even had her sign a contract for online safety.

The rules we follow at home are similar to those that have been established at her school. Her teacher confers with all the students' parents about the issues surrounding Internet use for children.

The Internet is not going to go away. On the contrary, it is likely to become more pervasive and even to replace books, magazines, and newspapers as our primary source of information. With our guidance, our children can safely add web literacy to their list of life skills.

Kimberly S. Roempler is ENC's Associate Director of Instructional Resources. She has been a teacher educator and a teacher of high school physical science. Email: roempler@enc.org

Write for *ENC Focus*



Detailed Writers' Guidelines are available online at

enc.org/focus/write

Guideline highlights:

Articles submitted for consideration should be grounded in the national educational standards while being short (500 to 2,000 words) and compelling. It is essential that articles promote educational equity and advance the principle of "education for all."

We particularly invite teachers to write about their classroom experiences, using first person and a conversational tone. We encourage inclusion of a few, carefully chosen references or a brief reading list. All content must be original, and all quotations must be properly cited. ENC is not interested in publishing articles that have the main goal of promoting commercial products.

Photos or other illustrations add interest, and good illustrations increase your chances for publication. Students in laboratory settings must be shown following appropriate safety guidelines and wearing proper safety attire, including eye protection. Please note that we can use photos of children under 18 years of age only if we receive written permission signed by a parent or guardian.

Authors of unsolicited manuscripts are urged to send a brief proposal via email well in advance of the deadline for the upcoming topic. We prefer that manuscripts be submitted electronically. Each manuscript must be accompanied by the full names, postal addresses, telephone numbers, and email addresses of all authors.

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ENC reserves the right to decline to publish any article, to delay publication until a later issue, or to publish an article online and not in the print version of the magazine. ENC retains the right to make final editing decisions.

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For upcoming topics, see page 5.

Gender Equitable Schools: They Benefit Everyone

by Sundra Flansburg, WEEA Equity Resource Center at the Education Development Center

In recent years, much of the coverage of gender equity in the news media tends to frame the issue in terms of "girls versus boys," or to assume that improvements in girls' educational achievement come at the expense of boys'. These arguments are often rooted in misconceptions about the work of those who promote gender equity in education.

Gender equity has never been about benefiting females more than males. When advocates and practitioners first began to work toward educational equity in the 1970s, they focused on girls and women because females experienced more discrimination than males in terms of access to educational resources and benefits. For instance, females were being shut out of or concentrated in certain classes (vocational education was especially sex-segregated), received substandard funding and opportunities in athletics, endured sexual harassment, faced quotas of maximum enrollments in professional schools, and so on. All of these barriers kept young women as a group—especially young women of color, poor women, and women with disabilities—from reaching their potential and being able to contribute fully to society.

Few people today deny publicly that this discrimination existed, or that the situation was blatantly unfair not only to females but also to society as a whole. However, some now state that in the 29 years since Title IX (the principal federal legislation guaranteeing educational equity) was passed, discrimination against girls has ended. Therefore, they argue, work aimed at girls is not only unnecessary but also thwarts boys' achievement.

Although the opposition groups' numbers are small, their skilled handling of the media has often garnered more attention for their opinions than what their numbers justify. While leaders opposing gender equity often seek media outlets and public recognition, this mode of work has not often been preferred by equity advocates and practitioners. Much has been written about the mass media's love of reporting "gender wars" or "battles of the sexes" (e.g., Tannen, 1999), but most gender equity supporters shy away from this approach.

Gender Equity Is About Males and Females

For decades, a number of gender equity advocates have been working in areas in which boys and men are disadvantaged. Both male and female researchers have identified the need to look at such issues as why African American boys are overrepresented in special education classes, why boys as a group do not perform as well as girls on verbal skills assessments, and why inappropriate expressions of anger and violence are concentrated disproportionately in the male population. Most equity advocates feel that many of the disadvantages boys face are the result of sex-role stereotyping and other related factors, and thus feel the issue of masculinity needs to be examined and challenged, just as notions of femininity have been.

Much work is already being done to address male issues with a gender equity focus. More is needed. Many specialists and researchers have called for greater atten-

ENC Focus *Article Sparks Discussion*

The controversy surrounding gender equity work in education has been building over the last several years. Recently, this controversy landed right here in *ENC Focus*.

Following publication of the article "Teacher Fellowships Close the Gender Gap," by Janalee Jordan-Meldrum and Tina Coplan of the American Association of University Women (AAUW), we received calls criticizing our coverage of gender equity as well as a letter from a school principal who wanted to know why there were no articles about disadvantages faced by boys. It has become politically incorrect, the principal said, to address gender equity for boys.

AAUW responded to the principal's concern by explaining that its goal is to encourage women to engage in high-tech education and careers "while also looking at the broader picture of what works best in schools for both girls and boys." (See ENC Online, enc.org/focus/equity to read the article, letter, and author's response.)

Because the topic has sparked so much response from our readers, ENC invited the director of the Women's Educational Equity Act (WEEA) Equity Resource Center to discuss the controversy surrounding gender equity. See the article on this page.

Let us know what you think. Send your comments to editor@enc.org

tion to these problems. This reflects an evolution in gender equity work and theory, as would be expected as the field matures.

A number of researchers have pointed out that more than three decades of work have led us to see that gender equity is more complex than many people first imagined. For instance, Barbara Bank reflects that

> *...As far as schooling is concerned, there is considerable evidence to support the conclusion that girls not only have absorbed the message that they should achieve but also have been successful in doing so. . . . Despite their good grades and other educational achievements, girls and women have not been able to win the status and other rewards that are consistent with their educational credentials. (Bank, 1997, pp. 10-11)*

Patricia Campbell and Nancy Kreinberg (1998) have noted the shift from seeing "access and treatment at the core of accountability" to recognizing "outcomes at the core of accountability." So while we should celebrate the advances made in terms of narrowing the gaps between young women's and men's achievement in a number of areas, we have found that this does not automatically ensure equitable outcomes. For one, women are still paid less than men with similar educational levels in similar jobs. In other words, helping females achieve economic self-sufficiency has proved to be much more complicated than simply removing discriminatory barriers to equitable education.

We have also found that equity work to improve girls' achievement has positively affected boys' achievement as well. Susan McGee Bailey and Patricia Campbell state that

> *...We must get past the idea that education is a zero sum game where a step forward for girls is automatically a step backward for boys. . . . Teachers know that when something works for girls, it often works for boys as well. For example, providing students with hands-on experiments reflecting the ways science relates to daily life has proven helpful in involving girls in science. This approach works for boys, too. Not allowing student "putdowns" makes many girls feel more comfortable in class, and boys find they also learn better when they don't have to worry about being teased or insulted. (1999)*

For instance, the teacher professional development program Generating Expectations for Student Achievement (GESA) was originally developed to address gender disparities in teacher-student interactions but was later reshaped to focus on race and ethnicity as well. Not only did GESA reduce the disparities between teacher interactions with males and females, but students in GESA classrooms also significantly improved achievement in both reading and mathematics. Not just girls, but all student groups. These results and other data show that focusing on gender equity in education often helps all students.

We cannot talk of excellence in schools without speaking of equity. By definition, high-performing schools must be equitable schools, since excellence has not been attained if there are achievement and outcome gaps by gender, race/ethnicity, class, or other factors. This connection between excellence and equity was the focus of several sessions at recent Improving America's Schools conferences sponsored by the U.S. Department of Education.

Why We Must Continue to Work

Work in gender equity aims to eliminate disparities in outcomes between females and males to benefit all students. It is about opening up our educational system to support expanded opportunities and achievement for both sexes—not just removing arbitrary and systemic barriers but also creating an environment in which all young people feel respected and challenged to reach their full potential. As a recent WEEA publication confirms:

> *Gender equity means creating an educational climate that encourages females and males equally to develop, achieve, and learn—without setting any limits on our expectations based on gender, race, ethnicity, or disability. Gender equity is inclusive. It supports the education of boys and is integral to the achievement of students of color, students with disabilities, and students from poor households. . .*
>
> *When we achieve gender equity, our education system will provide an equal chance to learn for females and males, open options to learn subjects and prepare for future education, jobs, physical activity, careers, and family responsibilities, with no limits on expectations due to gender, equal encouragement for both genders to develop, achieve, and learn, [and] equitable treatment of male and female students. (WEEA Equity Resource Center, 1998, p. 3)*

Recognizing and working on the issues that disadvantage boys and young men is vital. This does not mean, however, that work with girls and young women can or should end. In spite of hard-won gains, women continue to face greater obstacles than men in such areas as becoming economically self-sufficient, balancing the multiple demands of productive and reproductive roles, and so on.

Ignoring or failing to fully take into account these facts as we work in education would be unconscionable and irresponsible. Knowing this, our work with girls and

women continues to be of utmost importance, especially research and practice that benefit females of color, females with disabilities, and poor females. Work to improve educational opportunities for women and girls who face barriers due not only to gender but also to other factors has been at the core of the Women's Educational Equity Act Program's work for many years.

Advances have been made, which is reassuring for females and for society because this shows that it is possible to improve women's status in their communities. Many gains have been made, but with these gains comes the realization that many more inequities exist. For instance, while access and outcomes have improved for white, middle-class females in general, gains have been minimal for poor females and females of color. This points to the continuing need to collect data disaggregated by gender, race/ethnicity, disability, socioeconomic class, and other factors so that we can identify problems that may affect different groups in different ways. Interventions also need to focus on specific groups of girls and women, for example, females with disabilities.

As many have noted, gender equity work seems to get more complicated rather than less. With successes comes increased scrutiny, and we have found that it was easier to win support for the struggles against the blatant discriminatory policies of the past than against the current lingering effects of sex-role stereotyping or unconscious bias. But we cannot fall back on simple answers or sound bites. We have learned that good teaching engages all students, with no disparities by gender, race, ethnicity, class, or disability. This is what a great number of practitioners and advocates continue to strive for.

Sundra Flansburg is director of the Women's Educational Equity Act Equity Resource Center at the Education Development Center. She has written and published in such areas as women's human rights and self-esteem and the role of legislation in educational equity efforts. She has also worked and studied in Latin America on women's issues. This article, however, was written in her capacity as a private citizen and does not necessarily reflect the opinion of the U.S. Department of Education, funder of the WEEA Equity Resource Center.

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Visit ENC's Web Site enc.org

ENC Online is designed to make the resources of the Eisenhower National Clearinghouse available to educators everywhere all the time. Here is a quick introduction to the site. We urge you to "jump online" and discover for yourself how helpful enc.org can be to you.

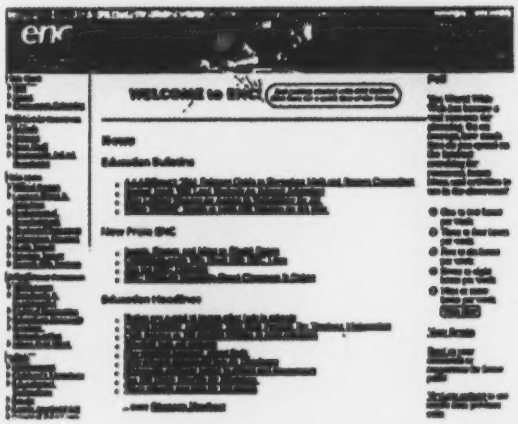
Curriculum Resources. In this area of the site, you can use a simple or advanced search to locate all types of teaching materials in ENC's collection of more than 19,000 items. The searches allow you to choose particular subject words, grade level, cost, and type of material to find exactly what you need for your classroom situation.

Web Links. Check this category for ENC's popular Digital Dozen feature. This monthly selection of exemplary math and science web sites can also be delivered to your email box if you choose to register. Web Links also connects to hundreds of sites with math and science lesson plans. A search feature helps you find Internet resources quickly and efficiently.

Professional Resources. This portion of the site is designed as a teachers' professional support system. ENC has gathered some of the most popular professional resources in one Timesavers area for quick linking and use. This section also provides links to the national mathematics and science education standards, and state frameworks are listed conveniently by state. Federally funded resources and professional development strategies are also available here.

Topics. Hundreds of articles, teacher interviews, and selected curriculum resources and web sites are arranged thematically in this area. Topics include inquiry and problem solving, educational technology, equity, and assessment. Many of these topics include the content developed for *ENC Focus*.

ENC Online also has a quick way to get to the full text of each issue of *ENC Focus*—try the ENC Focus Magazine area of the web site. In this area, you can also sign up for a free subscription to all future issues of the print magazine.



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Ohio Resource Center
for Mathematics, Science, and Reading

On-demand information delivery is the goal of state-level web sites that are the beginning of a linked network designed to meet the needs of educators.

by Peggy Kasten, Ohio Resource Center

It seems only fitting that Ohio would be among the first states to develop the type of Internet portal proposed by the National Commission on Mathematics and Science Teaching for the 21st Century. The Commission was chaired by Buckeye native, former astronaut, and former U.S. Senator from Ohio, John Glenn. Indeed, it is often referred to as the Glenn Commission. In its widely quoted report *Before It's Too Late*, published in 2000, the Commission made a powerful argument for "an interactive, conversational web resource dedicated to science and mathematics instruction, (that) would provide links to an ever-expanding knowledge base that would be invaluable in supporting high-quality professional development."

The Commission described an Internet site that would provide

- an online professional journal that encourages teachers to engage in publishable research and to share teaching strategies nationally and internationally;
- access to web sites with real-time data and experiences to support high-quality teaching and learning;
- a dedicated database for mathematics and science teachers, containing teaching ideas, lesson plans, student work, and other resources;
- an interactive, online resource for conversations, meetings, and idea sharing;
- an outlet to distance-learning courses in science and math for K-12 students and teachers; and
- interactive videos for observing good teachers and critiquing teachers' own teaching, for mentoring, and for online instruction.

Several states, including Ohio, have begun working on state-level web sites. It does not appear that any state site provides all of the resources and services that are suggested in the Glenn Commission report, but each of them addresses at least some part of the Internet portal.

Progress in Michigan, North Carolina, and Minnesota

Examples of statewide, resource-focused web sites are found in Michigan, North Carolina, and Minnesota. While different in their organization, operation, sponsorship, and range of services, each site attempts to provide direct access for teachers and others to resources and ideas that will improve teaching.

The Michigan Teacher Network (mtn.merit.edu) supports educators in the use of technology by providing access to evaluated information and materials. These high-quality resources can be used with students in the classroom, for professional development, or for educational planning and problem solving.

The North Carolina web site, Teachers Connect (www.teachers-connect.net), provides resources that support the development of high-quality teachers. One of the goals of the web site is to advocate for technology in education.

EdSTAR Minnesota (edstar.ncrel.org) is a collaborative effort of the Minnesota Department of Children, Families, and Learning, the North Central Regional Educational Laboratory, and the North Central Mathematics and Science Consortium. The goal is to give teachers substantive help, direction, and professional development in implementing the state's graduation standards. This site includes all subject areas.

The Ohio Model

In Ohio, the development of a web site that will address the Glenn Commission report is a part of a push to link higher education, state resources, and preK-12 schools in closing the gap between actual and desired performance in mathematics, science, and reading. Initially a project of the State University Education Deans, the Ohio Resource Center (ORC) was established by the Ohio Board of Regents and is funded by the Ohio General Assembly. (The Ohio Board of Regents represents all colleges and universities in the state.)

The ORC is expected to

- identify and disseminate best practices in instruction and professional development to schools, school districts, and higher education;
- support sustained professional development for teachers and administrators in the adoption of best practices and teaching resources; and
- foster an integrated educational research and development capacity for Ohio through collaboration with colleges and universities involved in teacher preparation.

The ORC operates as a virtual clearinghouse, with its resources available to all via the World Wide Web. The site is organized around Ohio's academic content standards. Its offerings are coordinated with other state and regional efforts to improve student achievement and teacher effectiveness in K-12 mathematics, science, and reading.

For teachers and teacher educators, the most visible part of the virtual clearinghouse is the database of teaching ideas, lesson plans, sample assessments, and other resources that support Ohio's academic content standards. All resources on the web site are rated as "best practice," "promising practice," or "informational." The best-practice resources are suitable for different purposes and for different audiences, but all are certified through a peer-review process that assures the validity of each of the identified practices for its intended purpose.

Visit the Ohio Resource Center web site (ohiorc.org)!

Users can find information by browsing or searching and they can be notified by email about specific items. Information can be filtered by grade level, specific standards, content topic, or type (best practice, promising practice, or informational).

The email feature allows users to request email notification of additions to the site. Eventually, users will have access, through ORC's web site, to a personalized web page that will identify and make available information resources that are of particular interest to them.

Users can also provide feedback about the resources and activities that are available as well as about the web site itself. As users register for email notification on particular topics, data can be gathered about specific needs of Ohio educators. This information can be used in decision making about the site and for other policy considerations.

Along with disseminating best practices and information, ORC expects to assist with implementing and institutionalizing these practices in the schools. We also hope to communicate with the public and business groups on matters of educational policy.

The accessibility of the World Wide Web coupled with the technology to search for specific information provides an opportunity for educators to address some of our greatest challenges: on demand, job-embedded professional development, equity of access to information and resources, and data-based decision-making to identify effective educational practice.

These new state-level web sites mark the beginning of a linked network designed to support the particular and specific needs of educators in individual states. The potential for improving teaching and learning is unlimited.

Peggy Kasten is the director of the Ohio Resource Center. She comes to ORC from the Ohio Department of Education, where she was the assistant director for comprehensive school improvement. Kasten began her career as a high school mathematics teacher in California and Missouri. Email: pkasten@enc.org

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The Eisenhower Network

ENC is part of the National Network of Eisenhower Regional Consortia and Clearinghouse, a nationwide collaboration that provides support to mathematics and science educators across the country. In addition to ENC, the Eisenhower Network includes ten Eisenhower Regional Consortia that work toward these goals:

- To identify and disseminate exemplary mathematics and science instructional materials;
- To provide technical assistance to educators in implementing teaching methods and assessment tools;
- To collaborate with local, state, regional, and national organizations engaged in educational improvement.

Also part of the Eisenhower Network are 12 ENC Demonstration Sites—one in each region, one at ENC in Columbus, Ohio, and one at The George Washington University in Washington DC. These sites provide users with the opportunity to access ENC services electronically and to pick up free publications.

In recent years, the Eisenhower Network has spread even further with the creation of ENC Access Centers. Located throughout the country, these volunteer centers are staffed to distribute ENC publications and to teach local educators about the Eisenhower Network. There are already 125 Access Centers, with more added each month.

Contact the Eisenhower Consortium or ENC Demonstration Site that serves your state for assistance in improving mathematics and science education.

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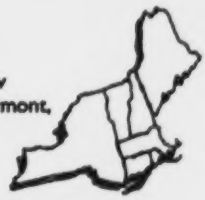

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ENC Capital Collection & Demonstration Site

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Dear Mrs. B., Please Reconsider. . .

An appeals process forces students to examine their approach to problem solving and gives teachers unique insight into students' mathematical reasoning.

by Lynn Bradley, North Middle School, Belleville, Michigan, and Joanne Caniglia, Eastern Michigan University, Ypsilanti, Michigan

When eighth graders at North Middle School in Belleville, Michigan, receive their graded test papers, there's no buzz of indignation, no comparison of papers, and no questions to the teacher. The young people know that the only way to protest a score or ask for an explanation of grading is to begin composing a letter of appeal.

Students can air their opinions in writing about what they perceive to be a mistake in grading or adding points, a poorly worded question, or an answer that they believe is wrongly marked incorrect.

The rules for submitting an appeal are:

1. Appeals will be in the form of a neatly written letter.
2. Appeals will be written on a piece of paper separate from the test and attached to the assignment in question. (Do not write on the test.)
3. Appeals must be content-based, not personal.
4. Insufficient time on a test or assignment is not a basis for an appeal.
5. Appeals must be very specific.
6. Students must communicate what action they would like taken (full credit, +1 point, +2 points).
7. Appeals are due the next class period.

The rules are posted and given to each student at the time the first test is returned. The teacher shows the students a sample appeals letter (see box on this page) and explains the required format. In the body of the letter, the student must begin a new paragraph for each issue he or she wants to discuss.

The appeals process benefits both the teacher and the student, and we have used it successfully in both middle and high school. The teacher knows that if she or he has misunderstood a student's reasoning or made a mistake in marking a test, the student can appeal the grade. Students have a method to voice their concerns, explain their reasoning, and ask for a higher score. The appeals process encourages students to test their ability to determine what is mathematically correct. When an appeal results in vindication of a student's arguments, the student gains confidence in his or her ability to reason mathematically.

We respond to the students' appeals as soon as possible—usually the next day—in writing. Samples of exchanges between teachers and students at several grade levels appear on pages 17 and 18.

In Letter 1, the student's appeal had to do with her interpretation of the wording in a problem. If the student had been able to clarify the problem, she would have received full credit.

Letter 2 is an example of an appeal from a precalculus student. It shows how students analyze their work, identify errors, and explain their reasoning. The teacher had originally marked the problem wrong, but after reviewing the appeals, she gave two additional points.

The appeals process is a valuable tool for gathering infor-

Sample Letter

Dear Mr. Sincic,

On my graphing quiz, on #7, I would like to clear up any confusion that there may have been. My work read:

Line 1 $(y-y_1) = m(x-x_1)$
Line 2 $(y-4) = m(x+2)$
Line 3 $(y-4) = -3/11(x+2)$
Line 4 $(y-4) = -3/11(x) + 1/2$
Line 5 $y = -3/11\,x + 7/2$

I just wanted to explain my work and possibly get an extra point. On line 3, and between line 4, I distributed -3/11, but I failed to write it down, so my next line obviously read:

$(y-4) = -3/11(x) + 1/2$, which is the proper distribution of -3/11.

Sincerely,

Brian

Teacher's Response:

This is still not correct. Please check your multiplication of fractions.

Letter 1

Question 4: List all the combinations of heads and tails when three coins are tossed at one time.

Question 10: Find the probability of choosing a face card in a standard deck of 52 cards.

Dear Mrs. Bradley,

On number four I read the question and I put down all combinations of heads and tails. I crossed out two combinations because the question said "heads and tails combinations." My interpretation is that there has to be heads or tails on at least one. The outcome has to have a head or tail because if it is all heads then it wouldn't be a heads and tails combination. The same goes for all tails. A better wording would be...outcomes of heads and (or) tails combinations. The answer I came up with was six combinations. When I have six combinations, the probability that exactly two heads will show up is three out of six, which reduces to one-half.

On number ten, I do not think that it was a fair question because I do not play cards a lot. When you said a face card, I just assumed that you meant any card because I had no idea what cards were face cards and what were not. I do know that half are black and half are red, so I put down that the probability of drawing a red card is one-half.

Sincerely,

Jane

Teacher's Response:

Paragraph 1: +1
Paragraph 2: +2

mation. It shows the teacher where and how students are having difficulty. For example, the student's comment about not being familiar with playing cards (Letter 1) reminded the teacher of the dangers of assuming all students bring the same experiences to school. The appeals process does not allow students to make excuses, but it does allow them to explain their mathematical reasoning based on their knowledge and personal experiences.

In the appeal described in Letter 3 (page 18), the student wrote an informative paragraph on a true/false question. The teacher was able to see that the student had a good understanding of parallel lines yet had difficulty deciding whether the statement was true or false. If the lines were in the same plane, the statement was true; if the lines were in different planes, the statement was false. In follow-up discussions with students, the teacher would not need to address parallel lines; she could instead discuss if/then statements. When time is limited (as it always seems to be), it is helpful to know where to start.

Letter 4 is another example of how appeals give us insight for making instructional decisions. This student is having some difficulty in understanding how to solve equations. He is trying to remember something from past instruction, which is not clear in his mind. Again, the appeal process identified a starting point for helping this student.

We have found that students feel comfortable with the process. Indeed, there is greater response from students when they know they will be listened to in a timely fashion. Many students

Letter 2

Question: Write an equation for an ellipse with one focus at (5,5) and vertices at (-2,5) and (10,5).

Dear Mrs. Bradley,

I would like you to take a closer look at number one on our recent test. I feel that the work that I did do was worthy of at least some partial credit, and I ask you to reconsider my point allotment. In the question, you ask for an equation of an ellipse. I completed the equation but then erased an uncertainty. I intended to return to it but that is beside the point.

This is what I wrote:

$$(x-4)^2 + \frac{(y-5)^2}{9} = 1$$

The lack of a denominator in the first part of the equation is due to my uncertainty. It is clearly noticeable that I wrote in 36 but erased it. Obviously, to write the complete equation, I must have known what I was doing. I successfully completed 4/5 of the equation and the other 1/5 was missed out of uncertainty and carelessness. Otherwise the rest of the equation is perfectly acceptable. I feel I have earned partial credit.

Sincerely,

Bill

Teacher's Response:

+2 points

Letter 3

Question: (True or False) If two lines do not intersect, then they must be parallel.

Dear Mr. Sincic,

My appeal is on the first page, number 7. The question states, "If two lines do not intersect, then they must be parallel." There is no real answer to this problem because nothing is said about the two lines being on the same plane. The answer would be true if these two lines were on the same plane. The answer would be false if these two lines were not on the same plane. Therefore, there is no correct answer since there was nothing about a plane written in the question.

I suggest +2 points if my appeal is heard because it is the value of the question.

Sincerely,
Melanie

Teacher's Response:

Therefore, the answer is false. If one can find one counter-example, the answer is false. Appeal for additional points denied.

show improvement in future tests because they think about the questions and their answers. In the event that a teacher error appears in a test problem, only those students who recognize it and write an appeal get added points.

The appeals process is time consuming, but the benefits to students and teachers are worth the time it takes. We also know that the appeals process exposes problems that are often overlooked, such as misconceptions or missing bits of information. Then, we can focus our time and attention on those deficiencies rather than reteaching an entire concept. Using an appeals process means that assessment does not end when we write a grade on a student's paper. Instead, the process provides a better understanding of the mathematical concept it was meant to assess.

We have used the appeals process with students in grades 8 to 12. As a technique for empowering students to take charge of their learning, it has been introduced in teacher preparation courses and to some inservice teachers.

The appeals process addresses the major "shift" in teaching methods called for in *Assessment Standards for School Mathematics* (NCTM, 1995):

> *We need to shift towards logic and mathematical evidence as verification—away from the teacher as the sole authority for right answers; towards mathematical reasoning—away from merely memorizing procedures; towards conjecture, inventing, and problem solving—away from an emphasis on mechanistic answer finding (p. 2).*

Lynn Bradley teaches at North Middle School in Belleville, Michigan. Joanne Caniglia teaches preservice and inservice teachers at Eastern Michigan University, Ypsilanti. Some of the letters in this article were provided by Tony Sincic, a math teacher at St. Patrick School in Brighton, Michigan, who has used the appeals process to motivate students to reflect on their work and to reason logically.

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Letter 4

Questions: Solve $x+7=3$

Solve $(5+2)+3=(5+x)$

Dear Mrs. Bradley,

I am appealing numbers 18 and 20. The way I was taught in algebra last year is that when we have a variable that involves addition we give what the variable could be as a positive number as well as negative number. So I put what the negative number for x would be. Therefore I got –17 for #18 and –15 for #20 along with the positive numbers.

$-17+7=3+7$

$(5+2)+3=(5-15)$

I would like +1 point since that was not the way I learned the math.

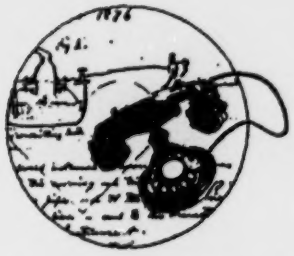
Sincerely,
Mark

Teacher's Response:

I don't understand what you mean by the technique you mentioned above. Please see me.

Introducing Classroom Calendar

Did you know that Albert Einstein was born on March 14—which is also Pi Day?



Or that Alexander Graham Bell patented the telephone on Valentine's Day?

Imagine your class celebrating Peanut Lover's Day by making their own peanut butter and reading about George Washington Carver.

Or perhaps your students would like to participate in National Rainforest Week with a community action project.

IDEAS like these and many more are available in Classroom Calendar, ENC Online's newest feature. For each Classroom Calendar item, we searched the World Wide Web and ENC's collection of more than 19,000 resources to identify our favorite materials for teaching the topic.

Classroom Calendar items include:

- A description of the event and how it relates to your curriculum
- Background information
- Ideas for cross-curricular connections
- A list of related web sites
- Classroom-ready online activities
- An annotated bibliography of ENC resources

Plus, each item is correlated to national mathematics and science standards.

Check out the September Classroom Calendar for

SEPTEMBER SUMS (K-Grade 3)

This event includes a collection of suggested games, classroom activities, and word problems that will smooth students' way through arithmetic. Children can use addition and multiplication throughout the school day, finding how many lunches are needed, how many books for the entire class, how much money for tickets, and so forth. Student activities also include games and tools, such as Math Baseball and Base Ten Blocks, that children can access on the Internet to improve their mathematical skills. Some might enjoy creating their own September Sums games or writing poems or story problems that incorporate the mathematical operations.

Jump online to see the full version of these items and many others throughout the year.
enc.org/calendar

Hurricane Hugo: Tracking a Killer Storm (Grades 5-12)

On September 21, 1989, Hurricane Hugo struck Charleston, South Carolina, after devastating the Caribbean. Satellite pictures made it possible to give ample warning to residents in the path of destruction, but many lives were lost and more than seven billion dollars of damage was done. Because hurricanes generate so much news, students readily see forecasting as a real-world application of science. Students can follow a hurricane (or other violent storm) through television and newspaper reports and write about its effects. They can also use the use data on how fast the storm is moving and its distance off shore to estimate when and where it will hit land.

Focus on

Becoming Literate in Mathematics and Science

This section presents articles on the theme of this issue

Themes for *ENC Focus*

Each issue of *ENC Focus* presents articles on a topic of concern to classroom innovators. Previous issues have covered topics such as Teaching in the Standards-Based Classroom, Making Schools Work for Every Child, Mathematics & Science in the Real World, Assessment That Informs Practice, Integrating Technology in the Classroom, and Inquiry & Problem Solving. The online version of *ENC Focus* (enc.org/focus) provides the full text of all issues.

The best source of new ideas and helpful tips for improving science and mathematics education is the classroom teacher. We invite you to join the community of *ENC Focus* writers. Check page 5 for upcoming themes. Our guidelines for writers appears on page 8 and online (enc.org/focus/write).

Mathematics

This leader in science education defines levels of literacy for all—scientists, mathematicians, teachers, and students.

by Frank X. Sutman, Rowan University, Glassboro, New Jersey

Before It's Too Late, the report from the National Commission on Mathematics and Science Teaching for the 21st Century, makes very clear the urgent need for all Americans to develop a higher level of mathematics and science literacy than presently exists:

> *From mathematics and the sciences will come the products, services, standard of living, and economic and military security that will sustain us at home and around the world. From them will come the technological creativity American companies need to compete effectively in the global marketplace.*

As a regular reader of *ENC Focus*, you are aware of the evidence indicating that we have a long way to go in attaining mathematics and science literacy. And you know about the many instructional resources available for mathematics and science. Likewise, as an *ENC Focus* reader, you are aware of the variety of professional development opportunities for teachers to learn how to use these materials.

Yet, there is a fundamental problem that prevents us from meeting the goal of mathematics and science literacy for all Americans. This problem is that teachers, themselves, are unclear about what is meant by literacy in these fields. This term, like so many other educational terms, has a vague and theoretical meaning for too many teachers and school administrators. Understanding is further obscured by education professionals who interchange literacy with acquisition of facts or who argue that no clear definition is possible.

One holder of the latter position is George DeBoer, a well-known science education researcher. In his article "Scientific Literacy: Another Look at Its Historical and Contemporary Meaning," DeBoer states, ". . .scientific literacy is undefinable and perhaps this is for the best" (2000).

DeBoer's history of the evolving understanding of science literacy quotes Morris Shamos, another well-known science educator, who expressed the opinion that "efforts to achieve scientific literacy among students are futile" (1995). Despite this, DeBoer supports the position taken by Shamos that "unless we (science educators) do develop and use a working definition (or description) for science literacy, we are in jeopardy of not reducing (but increasing) the continuing flood of books and articles deploring the sad state of this overall goal of science instruction."

Describing Mathematics and Science Literacy

Another position taken by DeBoer precipitated my own description of scientific literacy, which my professional judgment indicates can be expand-

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and Science Literacy for All Americans

ed to include mathematics literacy. DeBoer stated that "science literacy is limited to non-scientists, excluding practical scientists from the literacy requirement." I disagree. Scientists (and mathematicians), like all other citizens, have an obligation to become mathematics and science literate so they comprehend the significance of their knowledge to the issues that challenge society and can work with others in putting into practice the processes that lead to solutions.

Recognition of the need for a definition led me to develop a three-level description for mathematics and science literacy. Here it is, beginning with the simplest:

1. The ability to learn and to repeat learned mathematics and science content.
2. The ability and willingness to learn additional mathematics and science content on one's own.
3. The ability and willingness to develop and use mathematics and science processes to expand learning, to communicate with others about that learning, and to involve others in applying that which has been learned to address societal issues.

Each level of complexity subsumes the simpler levels, and there is no sharp line of distinction between one level and the next. There is, however, a "readiness" at which students are able to advance from one level of literacy to the next. This readiness varies from student to student.

This description for mathematics and science literacy is both realistic and functional. It overcomes the vagueness of the past and sets the stage for creating realistic standards for student learning. This is illustrated in the following example about inquiry learning.

Continued page 22.

Development of Mathematics and Science Literacy

Teachers can observe a number of clear-cut indicators that students are increasing their level of mathematics and science literacy. Examples of these indicators are included as questions below.

- Do my students refer to sources of information beyond the teacher and the textbook, such as handbooks, magazines, and the results of their own investigations, to discover answers to their inquiries?
- Do my students interact with their peers concerning mathematics and science concerns?
- At early grade levels, do my students willingly describe in writing to a friend the mathematics and science activities that they have completed and indicate what they learned?
- Do I (the teacher) share my positive mathematics and science experiences with peers?
- Am I integrating mathematics and science with each other and with other areas of study such as reading, writing, and social studies?
- Over several years, do my students' scores on high-stakes tests in mathematics and science, on average, improve?

Practices indicating a lack of support for mathematics and science literacy:

- Do I insist that all of the content in the textbook be covered?
- Do my students complain when asked to organize collected data into tables and graphs and then use these data in reports?
- Do I ask almost all of the questions?
- Are my students' questions limited to procedural questions?

Frank X. Sutman

The ability to practice inquiry (better stated as student inquiry or discovery) is a goal that pervades both national and state mathematics and science curriculum standards. The fact that younger children naturally inquire but later lose this skill tells us that this process must be encouraged through practice at a reasonably early age and continued throughout schooling. At the same time, the development of this skill needs to be supported through opportunities to participate in mathematics and science processes that lead to discovery.

These process skills include those associated with hands-on math and science but also must include the basic language skills of reading, listening, and writing. Without basic language skills, student inquiry and discovery will be ineffective. In fact, involving students in hands-on activities to answer their inquiries should serve to motivate students to read and write about mathematics and science and to be willing to learn from knowledgeable professionals in those fields.

Not until teachers attain at least the second level of mathematics and science literacy will they understand and begin to practice the tenets of the reform movement in mathematics and science instruction as proposed by the National Science Education Standards, the Project 2061 Benchmarks, the Principles and Standards for School Mathematics, and other standards that have evolved from these. Nor will teachers be able to implement these standards effectively unless they have developed their own mathematics and science literacy at the third level.

Cautions

Higher levels of mathematics and science literacy for both teachers and students will occur when the education culture allows both to be actively involved in investigations that lead to answers to their own questions. Teachers must be very careful not to ask too many of the questions so that students have ample opportunity to do so. To strengthen students' levels of mathematics and science literacy, teachers must allow adequate opportunity for students to make mistakes that the students themselves can then correct through their own inquiries.

The perception that it is possible for students to attain the highest level of mathematics and science literacy quickly is not accurate. To attain the highest level of literacy requires a concerted, conscious effort on the part of the entire education community to offer students sustained opportunities to develop it. Few upper-grade students practice literacy at the highest level because its development has not been a conscious goal throughout the grades.

Another reason that the highest level of mathematics and science literacy is rarely attained is because mathematics instruction is historically separated from science instruction. This separation results in the loss of wonderful opportunities to enhance both mathematics and science literacy. The teaching of mathematics by itself, solely through written word problems, may unconsciously integrate mathematics with language but does little to develop mathematics/science literacy. A commitment to combine the two disciplines will increase literacy for more students in both academic areas.

Finally, the increasingly popular "quick and dirty" approach of using special study sessions to improve performance on high-stakes mathematics and science tests may pay off over the short haul, but sustained higher test scores will result only when teachers work to enhance their own level of literacy and that of their students. It will take a clear understanding of the meaning of mathematics and science literacy as well as reform in how teachers approach instruction, at all school levels, to enable the next generation of citizens to be adequately prepared to meet the demands of the *Before It's Too Late* report.

Frank Sutman was the first recipient of the New Jersey Governor's Albert Einstein Award in Education for his "outstanding contributions in science education for minority teachers and their students." In addition to teaching science to school-aged children, he has been a professor of science and science education at universities in the United States and in five foreign countries. He also served as Dean of the College of Education at Montclair University, Upper Montclair, New Jersey. Presently, he is Visiting Senior Scholar at Morgan State University, Baltimore, Maryland, and also is Director of the Curriculum Development Council at Rowan University, Glassboro, New Jersey.

References and Suggested Readings

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A Nobel Laureate Talks to ENC

In a recent interview for *ENC Focus*, Leon Lederman, winner of the 1988 Nobel Prize in Physics, provided a few remarks about science literacy:

Survival in the 21st century is going to depend on the science literacy of the voting citizens.... In a high school, the goal is to produce people who feel comfortable with science and technology and are aware of the sources and resources that can help them understand the subject.... They know how to use the library; they know how to use the Internet.... Science literacy is the ability to think scientifically...and not to be bamboozled by fakers who make billions of dollars pretending to use scientific words with absolutely no meaning.

See the next issue of *ENC Focus* on the theme New Horizons in Mathematics and Science Education for more from the interview between Lederman and Judy Ridgway, ENC's Assistant Director of Instructional Resources. Their conversation centered on the debate surrounding changes to the high school science curriculum.

Innumerate and Proud of It

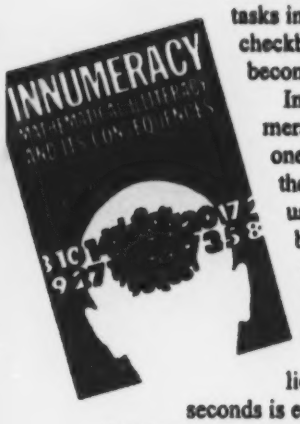
Mathematics teachers often feel that they are fighting an uphill battle. John Allen Paulos' books provide a cool drink for the climb.

by Mark Holtman, ENC Publishing

Unlike other failings, which are hidden, mathematical illiteracy is often flaunted: "I can't even balance my checkbook." "I'm a people person, not a numbers person." Or "I always hated math."

—Innumeracy: Mathematical Illiteracy and Its Social Consequences, *p 4.*

The fact that innumeracy is a label that otherwise literate, educated people wear with pride is one of the major problems outlined in mathematician John Allen Paulos' book, *Innumeracy: Mathematical Illiteracy and Its Social Consequences*. The result of this attitude, according to Paulos, is that many people are grossly innumerate when it comes to the simplest tasks involving numbers; balancing the checkbook and estimating a grocery bill become time-consuming projects.



In refuting society's myth that innumeracy is acceptable, Paulos steps from one example to the next, illuminating the mathematics behind it, and showing us that numbers are not something to be feared. He makes abstract ideas concrete, applying them to everyday scenarios that any one of us might encounter.

The difference between a million and a billion? One million seconds is equal to approximately 11 days. One billion seconds is equal to approximately 32 years. This gives us perspective on what it means to be a millionaire or a billionaire, and it illuminates the mind-boggling extent of our national debt, a figure that would be closer to 32,000 years on this time scale.

Paulos argues that being numerate also allows us to critically analyze and think about the news. We are less likely to believe every statistic we read if we are able to logically step through the process of how the numbers were generated. To this and other serious issues, Paulos brings a sense of humor. Visitors to his web site (math.temple.edu/~paulos) will notice in the upper-left-hand corner a blurb that reads:

First this: An exhaustive international study has revealed that 62.381527% of all statistics are made up on the spot.

Innumeracy is filled with anecdotes about everyday life that have a funny spin to them. His more recent work, *A Mathematician Reads the Newspaper*, shows readers how mathematics affects every facet of the news, be it politics or the obituaries.

Humor may be the vehicle through which Paulos delivers his message, but his reasons for writing are serious:

I'm distressed by a society which depends so completely on mathematics and science and yet seems so indifferent to the innumeracy and scientific illiteracy of so many of its citizens...the desire to arouse a sense of numerical proportion and an appreciation for the irreducibly probabilistic nature of life... was the primary motivation for the book.

—Innumeracy: Mathematical Illiteracy and Its Social Consequences, *p. 179*

Mark Holtman, a technical editor at ENC, prepares the online version of ENC Focus.
Email: mholtman@enc.org

Books by John Allen Paulos

Once Upon a Number. Basic Books, 1998.

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Beyond Numeracy: Ruminations of a Numbers Man. Knopf, 1991.

Innumeracy: Mathematical Illiteracy and Its Social Consequences. Farrar, Straus, and Giroux, 1989.

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It's About Relevancy

A chat with high school students reveals that they really do understand why it is important to become literate in mathematics and science.

by Carol Damian, ENC Instructional Resources

Why do I have to learn this? When will I ever use it?

How many times have you been asked these questions? When I think about students becoming adults who are literate in mathematics and science, it occurs to me that we should be asking our students to answer their two big questions. I've found that young people will respond, citing important, interesting, and relevant reasons for their studies. Literacy in math and science is about relevancy.

Recently, I was chatting with 15 young people and asked them why a person should study math and science in school. They gave reasons such as becoming well-rounded, getting into college, challenging oneself, needing to "take something" (no other interesting courses—or no choice), being with friends in classes, and choosing courses taught by teachers they like.

Then I probed further by paraphrasing the students' two big questions: "Do you think you'll ever use that stuff? Why should you have to learn all that science and math?" Some of them mentioned things like balancing checkbooks, converting liters to gallons at the gas pump, and learning how to make slime.

"Well," I asked, "do you suppose anything you're learning in math and science will ever come up in your everyday lives or in your future jobs?"

"Yes," one girl answered, "like when you charge a bunch of stuff on your credit card and find you'll never be able to pay it off at the humongous interest rate." I asked them if any of their classes prepared them for that kind of real-life shock. Girls and boys chimed in, offering that some classes do—the ones where they actually get to do real things, like simulate stock market investing, plan a model city, or role-play deciding about an organ transplant. They all said they were not sure about the value of other classes because the lessons seemed disconnected from anything real.

I asked the two big questions again, "When will you ever use that stuff? Why learn all that math and science?" They thought awhile, talked among themselves, then started rattling off these "reasons": banking/borrowing money, product consumer, family planning, waste disposal, car purchases (and energy/pollution concerns), transportation systems, global warming, safety, medicines, genetic engineering, politics, defense issues, earthquakes, usable water, food supplies, weather changes, materials for building and clothing, disabilities, understanding numbers and problem-solving, communication, computers, information gathering.... Seemingly disconnected answers, these "reasons" are a mirror of the issues adults face today.

The conversation went on for some time. I was fascinated. These students were quite capable of answering their own questions. More than that, they were defining what it means to be literate in mathematics and science. They were closing in on what is relevant in math and science to their lives now and in the future.

When students ask you their two big questions, ask them to help you think through the answers. As they respond, they will realize how important mathematics and science literacy is to all of us.

Carol Damian has 25 years experience as a high school physics teacher. Currently, she serves as ENC's science education specialist. Email: cdamian@enc.org

The Proving Ground for History

Thomas Kuhn's book* The Structure of Scientific Revolutions *provides answers to the questions students so often ask:

Why should I learn this? Why is this important?

by David O'Connell, ENC Publishing

When I was fourteen years old, I wanted to be an astronomer. Like many other people, what drew me to backyard stargazing was a fascination with the unknown. Was space really infinite? Was there a place where space, as we conceived of it, simply ended? If so, what then? Though I wouldn't have then articulated it in this way, my interest was as much philosophic and religious as it was mathematic and scientific. Most importantly, seeking answers to these questions seemed adventurous. Looking back, I see now how my interest in the movement of planets and the creation of galaxies was tied to my whole process of adolescence; I was trying to come to terms with my place in the universe.

Of course, my notions about the astronomer's life were terribly romantic. And yes, my interest was fueled by heavy doses of Arthur C. Clarke and Ray Bradbury. Even so, the slight quickening of pulse I felt when rooting through my high school library's old *Astronomy* magazines can't be explained away simply by this naiveté. Something within the nature of science, something at its core, seemed to necessitate romanticism. As a high school freshman, I sensed that science was the product of curiosity and imagination, the building blocks of creative thinking. I wanted to be a person who had such a mind.

My aspirations of being a scientist didn't last long. Somewhere between September and June of my junior year, between learning the Periodic Table and calculating moles in chemistry class, I lost the belief that science allowed for creativity. Each time my classmates and I fired up our Bunsen burners, I saw myself becoming part of a safety-goggled herd looking for a single correct answer.

Though I had my fair share of disasters in the lab, my frustration wasn't so much a result of failure. I had a good teacher and, with his help, became quite well informed in the process of science. I could pass the tests. I could meet most expectations. Nevertheless, as I acquired the skills necessary to get the right answers, I lost the sense of science as a creative enterprise. Where was there room for individuality when every answer was pre-existing? In other classes, particularly English, my ideas were valued. In science I felt my contributions were limited to the regurgitation of facts.

I struggled through physics and, by high school graduation, figured that I had done my time. In college I opted for the "science for nonscience majors" classes and doted on my new love, the Humanities. Then, in my junior year of college, with one science requirement left to fill, I read Thomas Kuhn's *The Structure of Scientific Revolutions* and was inspired to rethink my whole concept of science and my relation to it.

You Say You Want a Revolution?

Since its first printing in 1962 Kuhn's text stands as one of the most influential philosophic worl of the 20th century. Though this book about the scientific commu ty, Kuhn's ideas have reached far beyond his primary audience. Hi theory of paradigm shifts has fou its way into the disciplines of soc ology, literary criticism, and political science, to name just a f Kuhn's work has also had influen beyond the academy. Former pre dents George Bush (senior) and Clinton have both used terminol coined by Kuhn, and *Structure* is said to be Al Gore's favorite bool (Franklin).

When I first read *Structure*, I captivated by Kuhn's version of s

entific history. This was a history I had never comprehensively received in high school. While I was taught, and expected to memorize, the products of scientists' work over the ages, very little time was spent discussing the stories behind the creation of the formulas I used. This is unfortunate because I have always found it easier to remain focused on abstract work if I first know the concrete, human history behind its generation.

By providing history's panorama, stories about scientific achievement provide answers to the questions students like myself so often ask:

Why should I learn this?

Why is this important?

Moreover, because these are stories about the products of creative genius over the ages, scientific history proves the dynamic nature of the scientific world to the easily jaded student. I often wonder if I would have abandoned the sciences if I had had a better grasp of the human drama behind scientific advancement.

Instead of drama, most of the scientific history I did receive in school made scientific advancement out to be boringly linear: first came Ptolemy, next came Copernicus, and so forth. The whole process of learning this history was akin to memorizing a chronological list of Presidents without being provided any of the political struggles that gave rise to each.

Kuhn, on the other hand, describes scientific history as being essentially volatile. According to him, scientific history has been comprised of long bouts of "normal science" that are occasionally interrupted by what he terms "paradigm shifts." These paradigm shifts are moments in history when a theory forces the scientific community to see all of reality in a radically new way. Because this new vision is completely incompatible with the paradigm that preceded it, it must sever ties with its predecessor. According to Kuhn, this shift is not progressive, but revolutionary.

For example, in order for Copernicus' heliocentric model of the solar system to be accepted, astronomers were forced to abandon a paradigm (Ptolemy's geocentric model) that had sustained their community for almost eighteen hundred years. We can

only imagine how frightening this was. What we know for sure is that this shift was a slow and sometimes dangerous process. Galileo's heresy conviction and subsequent house arrest by the Inquisition is a classic example of the power struggle inherent to paradigm shifts. Though every revolution might not be as volatile as the Copernican, the drama behind scientific history is there for those who seek it out.

Kuhn in the K-12 Classroom

Though Kuhn's book is probably too technical for even the high school science curriculum, a reading of *Structure* would provide every teacher with a number of new ideas on how to bring the excitement of scientific history into their classrooms. Like any good historian, Kuhn pulls his reader into his book by painting the mindset of those who worked with a now defunct paradigm. By demonstrating how a paradigm that seems inconceivable to us today was once taken for granted, he challenges us to reexamine our own preconceptions and allows us to see that scientific answers are far from preexisting.

For example, I had never really considered how devastating it would be for a person who once accepted that the earth was the center of the universe to be forced to accept that it was, in fact, merely one of many planets speeding around the sun. Such a person must have wondered what else that he accepted as truth was actually illusion.

Naturally, I began asking myself the same questions. What exactly did I know for sure was true? How was I sure? How would I act if I had to abandon the notion that the earth revolved around the sun? These types of "big picture" questions are there for the asking, whether in biology, physics, or chemistry, and they can fuel students' interest in science.

Teachers may even experiment with role-playing, story and poem writing, and drawing in an attempt to concretize these questions and generate discussion. Far from diverting students' attention away from science, such techniques bring about the realization that one must turn to experimentation to answer these questions. This brings about unique opportunities. Unlike American or world history, scientific history allows students to take part in experiments that literally trace the paths of his or her scientific predecessors. The lab becomes the proving ground of history.

It should be pointed out that many critics vehemently disagree with Kuhn (Franklin). A number of these detractors have argued that Kuhn's model of scientific history is unduly influenced by sociologic theory. Regardless of whether or not Kuhn is right, the intensity of this ongoing critical debate demonstrates the inherent value of his theories. That Kuhn's model continues to draw both scientists and nonscientists alike into this dialogue is perhaps the greatest testament to his achievement.

I believe this dialogue to be more important today than when Kuhn first published *Structure*. As our society's dependence upon science and technology continues to grow, it is important that a broad-based contingent of the population feels comfortable enough—if only with the idea of science—to remain tuned in to the many issues related to scientific advancements that will be raised in the future.

While it is unrealistic to hope that every student will learn the necessary skills to fully understand these advancements, a general, conceptual knowledge of the scientific community would give every student a context within which to process the information he or she will read in the newspaper or see on television 20 years after graduation. Most important, this context would allow for an educated debate about the social and ethical ramifications of science upon society.

I will probably never go back into a physics or biology classroom. Nevertheless, I know that my overall interest in science is keener for having been exposed to Kuhn's theories. It seems to me that this lifelong interest in science, or science literacy, for every citizen has always been one of the goals of science education. It is often forgotten by the nonscientist that all scientific theories are attempts to discover truth. Those of us who shied away from science often fail to see it as an adult's way of carrying on the existential questioning that begins with adolescence. As with artists, philosophers, and writers, scientists' endeavors to ascertain truth are the most human of enterprises. It is the humanity of this field, demonstrated by the stories of the community's history, which could help K-12 students remain students for life.

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Talking Their Way to the Middle of All Numbers

Being mathematically literate entails being able to talk about mathematics. That is just what these first graders do. In turn, language becomes a tool for building mathematical literacy.

by Kristine Reed Woleck, Hudson, Massachusetts, Public Schools

Twenty-one first-grade mathematicians gathered around a thermometer just prior to lunch. The temperature was 25 degrees Celsius, prompting William to announce, "25 is halfway between 20 and 30! It's in the middle." Several others agreed. Then Whitney raised her hand. With her eyes squinting, she asked in a thoughtful voice, "I'm wondering, what is the middle of all numbers?"

All too often the teacher's voice dominates the classroom. The teacher poses the questions; the students respond. But the *Professional Standards for Teaching*

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Mathematics (NCTM, 1991) and, more recently, the *Principles and Standards for School Mathematics* (NCTM, 2000) put forth a vision of classroom discourse as one in which students raise questions and even initiate mathematical problems. Students clarify and defend their own conjectures and solutions to peers, becoming an audience for one another. At the same time, teachers do more listening. Teachers open their ears to the questions and conversations of young mathematicians.

Fortunately, my ears were open that day in Room 1R, our first-grade classroom, when Whitney posed a question that intrigued her classmates. I allowed the classroom discourse to evolve not from my voice and agenda, but from the voices and mathematical ideas of the children. I let them talk.

What follows is a powerful mathematical conversation in the children's own words. I let young mathematicians talk, and this is what they said.

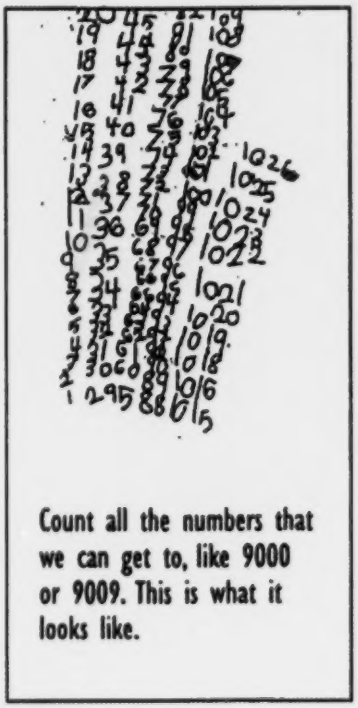
What Is the Middle of All Numbers?

As soon as Whitney posed her question, Ryan exclaimed, "Fifty is the middle, because 50 plus 50 equals 100." Elizabeth did not agree and responded matter-of-factly, "But you can count more than 100." Others in the group echoed their agreement, and for a moment, no one said a word; I let them think. I could sense that this concept was intriguing to them.

Then came Antoine's comment, "There's no middle number because numbers never stop." Kevin confirmed this, "Every number keeps going. There's too many to count." Others agreed, and, for a moment, the group seemed content to accept the idea that no solution could be determined.

But Whitney persisted, offering her strategy to render the problem more accessible, "I think we should count as high as we can and write all the numbers down on paper and then fold it and put the two sides of numbers together. Then we'll get the middle. If you count to an even number, then there'll be two numbers in the middle. If it's an odd number, then there's one number in the middle."

Some in the group were confused by Whitney's visual image. "I don't get it," Elizabeth said to Whitney. As we



Count all the numbers that we can get to, like 9000 or 9009. This is what it looks like.

Figure 1.

postponed the conversation to break for lunch, Whitney headed off to gather paper and a pencil; she made a drawing of her idea to share with the group (Figure 1). Antoine recorded our "middle of all numbers" question on the list of "Problems We Are Thinking About," which hung on the classroom door.

And, indeed, it was a problem that the group was thinking about. During a whole-group meeting later that afternoon, conjectures from others in the group continued. Peter suggested, "I think there must be a couple of numbers, not just one in the middle, because there's a lot of numbers." Jason proposed, "It would be an odd number, because five is the middle when you count to 10, and it's like one, three, five. Three is in the middle and three is odd." William offered yet another theory, "There can be all different middles. You can choose. It depends on how far you can count."

Kevin then reminded the group, "The problem is numbers never stop." Whitney pondered this for a moment and asked, "Well, the numbers go so far up, but what's the biggest negative number?"

Pointing to the number line from –12 to 120 hanging in the classroom, Shanika was quick to respond, "It's the same as how high you can count. It goes both ways." Several others confirmed her idea, echoing that "negative numbers go as far as the numbers you count with."

This notion ignited Frank's thinking. He suddenly pointed to the number line and exclaimed with confidence, "I think 1 is the middle number. You can go all the way in negative numbers to the hundreds and then all the other numbers go the other way." Nods of agreement could be seen as others in the group considered Frank's reasoning.

The time seemed right for a question that would prompt the children to reflect. I called their attention to the number line. Each positive number was marked with a red star below it; each negative number was marked with a black star below it. No star marked zero. I asked, "What about zero in this problem?"

Referring to a question we had debated earlier in the year, Kevin replied, "Well, we're not sure if zero really is a number. We need to decide that first to know where it

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goes." Then Antoine offered his thoughts, "Maybe zero is the middle. Maybe it is a number. The negatives keep going (he pointed to the left of the number line), and then the one starts all the numbers getting bigger (he pointed to the right of the number line)."

For a brief moment, no one spoke as they worked to make sense of Antoine's idea and reasoning. Then there came a hum of excitement as several members of the group turned to one another, articulating and proving Antoine's solution for themselves. Frank, too, announced that he had changed his mind and agreed with Antoine. He joined Antoine to record their thoughts, solution, and mathematical justification in the Room 1R Mathematicians' Notebook (Figure 2). The excitement and sense of empowerment could be felt throughout the group.

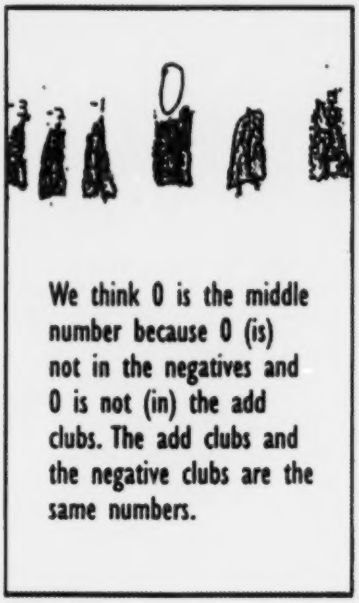
We think 0 is the middle number because 0 (is) not in the negatives and 0 is not (in) the add clubs. The add clubs and the negative clubs are the same numbers.

Figure 2.

How Did This Happen?

Here were young mathematicians talking mathematics with one another. They were theorizing, challenging each other's ideas, questioning their own reasoning, and investigating the science of mathematics. But, how was it that these six and seven year olds could examine the theoretical, abstract notions of number theory embedded in Whitney's "middle of all numbers" problem?

I believe it was possible because these students constructed their ideas and understandings using their own language. Research has pointed to the manner in which children's use of their own informal language can support their construction and abstraction of mathematical ideas (Cramer & Karnowski, 1995).

The children explored the notion of infinity in their dialogue, and they brought meaning to this extremely abstract mathematical idea using everyday language: "numbers never stop," "every number keeps going." No adult hastily introduced technical vocabulary into the conversation; this could come later. Instead, the students had the opportunity to communicate their own understanding of the concept with their own shared language. They shared their mathematical ideas in a manner that was accessible and meaningful to their community of young learners.

A Mathematical Tool for All

With the conversation grounded in their own mathematical language, the first-graders felt confident enough to pursue the problem until they arrived at a solution that they could prove mathematically. It is true that not all of the children in the group grasped the abstract notions that Antoine and Frank proposed in their solution; after all, the "big ideas" of mathematics develop at different rates for each learner. Those children will revisit and refine their understandings of infinity and number theory again and again in later years.

Whitney's problem provided multiple entry points, which allowed the range of learners in the group to participate in the discussion and explore numbers at their present level of understanding. The willingness of so many in the group to put forth their thoughts and solutions speaks to the power of the children's own mathematical language and the safe, respectful climate of the classroom.

The young mathematicians of Room 1R had the opportunity to talk to each other, as do adult mathematicians across the world. They had the opportunity to discuss mathematics using a language they shared in their own learning community. They developed their own mathematical voices. These are the voices we need to hear and respect. Perhaps, then, time to talk is the most powerful tool that teachers can provide to young mathematicians in the classroom.

Kristine Reed Woleck presently serves as a K-8 mathematics staff developer in conjunction with a National Science Foundation Local Systemic Change initiative in Hudson, Massachusetts. A graduate of the Bank Street College of Education's Leadership in Mathematics Education program, she was previously a first-grade classroom teacher and K-3 instructional leader in Wilton, Connecticut, the setting of this article.

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Graphing Savvy: Giving Students a Sense of Mathematical Power

Graphs can easily imply more (or less) than their numbers tell. Students from fourth grade to high school learn how to look beyond first impressions and become more savvy consumers of information.

by Sue McMillen, Buffalo State College, Buffalo, New York

As a beginning math teacher I viewed graphs as an endpoint. When students had gathered their data and constructed a graph, they were done. Now I view graphs as a starting point for discussion and reflection, leading to increased mathematical literacy. To be mathematically literate, students must be able to both construct and interpret graphs.

Books, newspapers, magazines, advertisements, and web sites use graphs as an information source. Graphs also play an important role in the study of mathematics (NCTM, 2000), science (Rogers, 1995), and social studies (Garofalo, 1999). However, graphs can be used to give differing impressions or even distorted visual images of information. Changing the vertical or horizontal scales (or both) can either highlight or conceal relationships among the data values.

Research has shown that students often have little understanding of how changing the scaling unit changes the appearance of graph data (McMillen, 1993; Rogers, 1995). Yet, *Principles and Standards for School Mathematics* states "students in grades six to eight should begin to compare the effectiveness of various types of displays" (p. 49). Clearly, students need to understand how the choice of a scaling unit impacts the appearance of information in graphs. They need to develop the ability to work with more than one scaling unit.

Simply exposing students to different graphs with various scaling units will not illustrate the effect of scaling units. Because each graph represents a different situation, the students do not easily see the effect of the scaling unit. Rather, students need experience in representing the same data on differently scaled axes. This allows them to observe, reflect on, and make conjectures about the effect that various scale choices would have.

The activities described here were used with students in grades 4 through 12. Changing scaling units on both coordinate graphs and bar graphs led the students to a better understanding of the visual impact of scale choices.

Suggestions for Teachers

The ability to understand information conveyed in graphs without being misled by visual images is an attribute of mathematical literacy. Here are some suggestions for implementing the instruction described in this article.

- Use the same size grid with the same number of gridlines for all variations of a graph when illustrating shrinking and stretching scaling units.
- Emphasize again and again that the data remains the same as the graphs change in appearance due to changing scales.
- Have students identify graph features, such as maximum or minimum values, that remain the same even when the scaling units are changed.
- Use graphing calculators and other graphing technologies for fast and accurate redrawing of graphs using the same data.
- Demonstrate that the choice of scaling units impacts the appearance of all types of graphs, including line graphs, histograms, or graphs of functions.

Coordinate Graph Activities

As a beginning exercise, fourth- and fifth-grade students plotted the same points on the same size grid, but used different scaling units. For example, the points (10, 6) and (2, 8) were plotted on the three grids shown in Figure 1. (The students plotted the points by hand.)

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Figure 1a

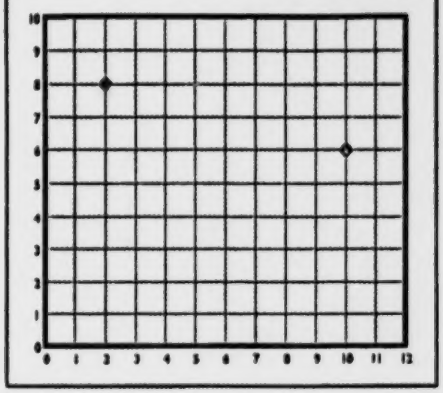
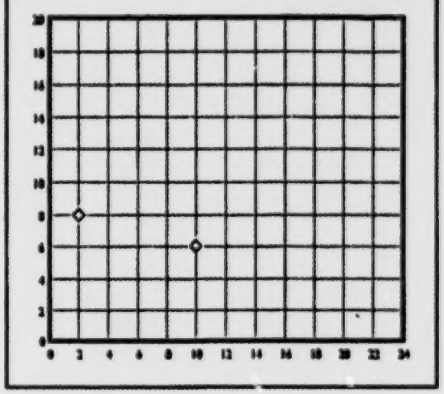
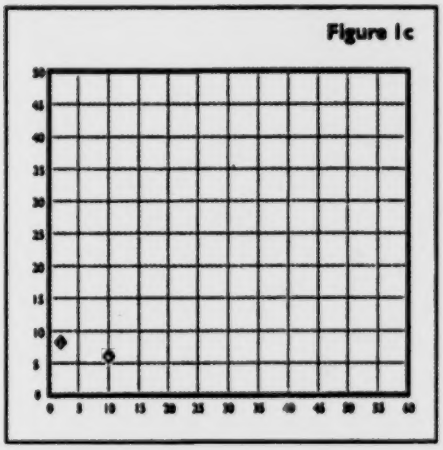


Figure 1b



The students were both intrigued and surprised to see how different the graphs looked, although the coordinates of the points were the same on all three graphs. I asked them to tell me what was the same and what was different on the graphs. Here are some of their responses:

Figure 1c



Sasha (pointing to the upper portion of the y-axis in Figure 1c): The points on the last graph don't have to go up high.

James (referring to Figure 1c): How can the points be so much closer to each other on the third graph when the numbers are the same?

Keisha (referring to Figure 1c): I don't like the last graph because it is too empty.

Marta: The first point is always a little higher than the second.

James: It's further left, too.

In other classrooms, I have asked the students to predict what the second and third graphs would look like before they drew them. For other graphing exercises, I allowed the students to choose their scaling unit as long as all the points could be plotted on the grid. Class discussion of this activity revealed that some students had developed an accurate understanding of the visual impact of changing the scales on the axes.

Daunte drew the graph in Figure 2a, labeling both axes by tens. When I asked him what would happen to his points if he chose fives as a scaling unit, he replied, "They would go up higher." Moving his pencil from the lower left to the upper right of the grid, he said, "They would go up higher and move over more" (McMillen, 1993, p. 197).

Antonio drew the graph in Figure 2b, labeling both axes by fives. While discussing his graph, he mentioned that he could have labeled it by tens. Asked why he might have chosen tens, he answered, "In case you want to go further or more on the bottom (moving his hand to the far right of the grid). Or you want to go longer (spreading his hands apart in a horizontal direction)" (McMillen, 1993, p. 271).

Figure 2a

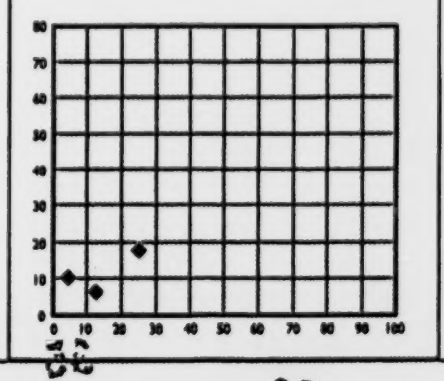
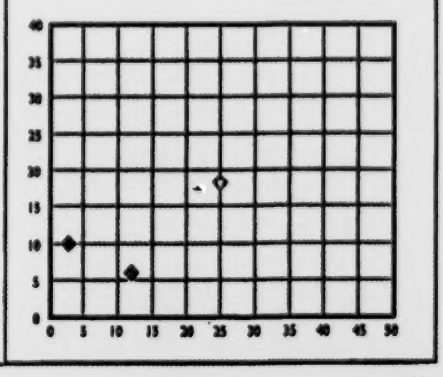
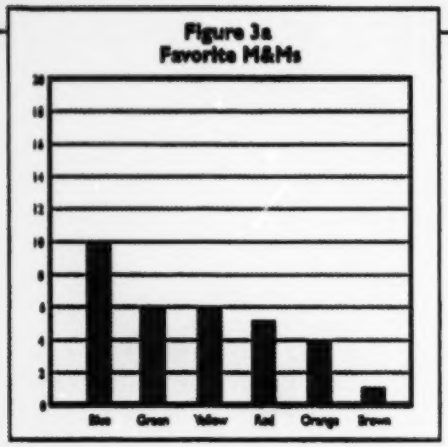


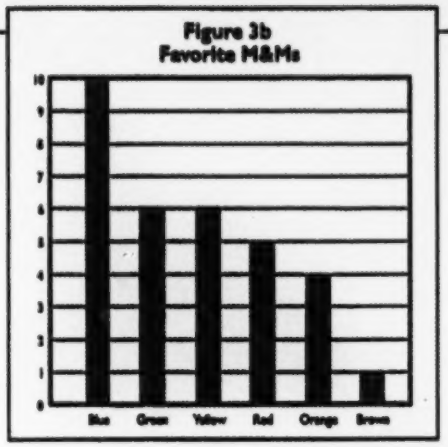
Figure 2b



Bar Graph Activities

I used a similar activity with students in grades 4 through 12 who were constructing bar graphs. The students in a fifth-grade class constructed the bar graph in Figure 3a (see p. 34) to show class members' favorite color for M&M's ™ candies using twos as the scale. Next they redrew the graph using a smaller scaling unit (Figure 3b) and a larger scaling unit (Figure 3c), but using the same number of grid lines. Again we discussed similarities and differences. The students





observed that the bar for blue was always the tallest bar, but sometimes its height was closer to the height of the other bars. I emphasized that the numbers represented by each bar did not change from graph to graph, but the appearance of the bars changed because of the change in scale.

Among the comments made by the fifth graders were:

Benito: "The spaces between the bars look like they are still the same."

Mila: "The tallest bar is still for blue."

Nathan: "On the third one [3c], blue is only a little ahead of the others."

Matthew: "Sometimes the bar for blue is a lot taller than the rest. But, sometimes it's only a little taller."

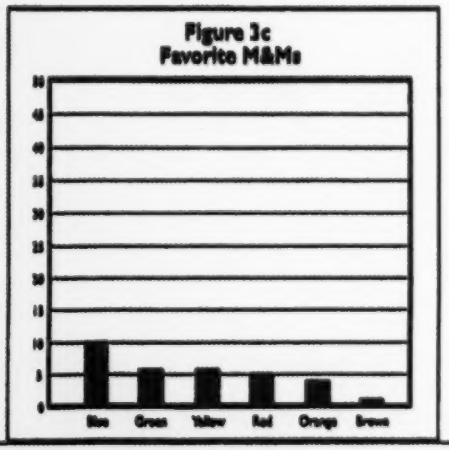
Amanda: "Green and yellow are always the same."

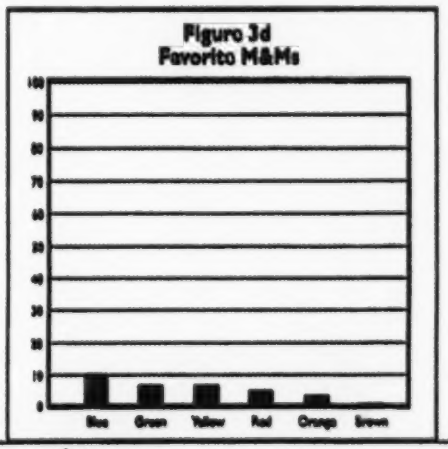
We then discussed which graph would appeal to a person who liked blue M&M's best and which would be preferred by a person who liked green best. The children noted that Figure 3b might be preferred by persons liking blue because the blue bar "is really tall." They decided that the person who liked green M&M's would choose Figure 3c "because the bars are almost all the same."

Finally, I asked the fourth and fifth graders to construct a graph that would please someone whose favorite M&M's color was brown. As a class, they predicted this assignment would be "pretty hard, because only one person picked brown." After working a while, one group constructed the bar graph shown in Figure 3d, which uses units of ten. After discussion, the class conjectured that a "very large" scaling unit would make all of the bars "really low." As each group searched for the largest scaling unit, they came to realize that a scaling unit of 500 or 1,000 would make the heights of the bars hard to distinguish. They also discovered that it was too hard to draw a bar of height 10 when the scaling unit was so large. In spite of this, they were quite pleased with their newfound sense of control, which came from stretching or shrinking a bar graph by changing the scaling unit.

With high school-age students, I carried this idea further. These students found and analyzed bar graphs from newspapers and magazines. I asked them to identify the group or organization that prepared the graph. Then the students redrew the graph choosing a scaling unit that would favor a different group or point of view.

For example, a bar graph might show increases in a school district's budget each year for the past five years.





A taxpayers' group, opposed to higher taxes, might choose small scaling units for a bar graph, thus accentuating the increases. The school board might be more likely to choose a larger scaling unit to make the increases appear less dramatic.

Truncated Graphs

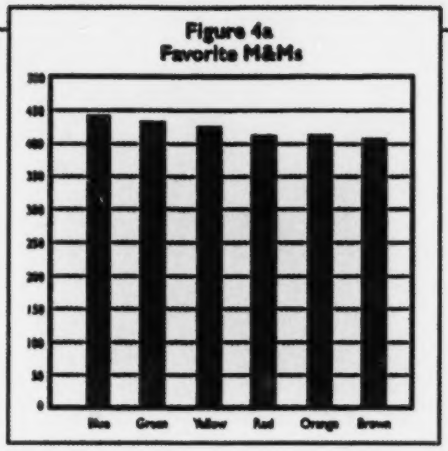
Middle school and high school students also worked with graphs whose axes had been cut off, or truncated. When part of the vertical axis is missing, the differences among the bars of a bar graph or histogram are exaggerated. For example, suppose the bar graph in Figure 4a represents the favorite M&M's colors for all the students in a large school. While 444 students chose blue, 415 chose brown. Figure 4b shows a truncated version of the graph, displaying only the portion of the bars from 400 to 450.

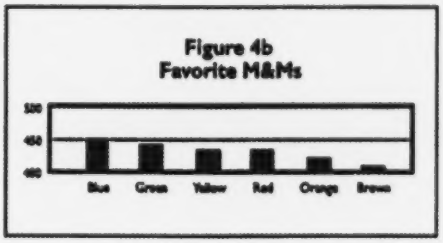
Truncated graphs are commonly rescaled and elongated as in Figure 4c, but this exaggerates the difference among the heights of the bars. In Figure 4c, it appears that about seven times as many students prefer blue as prefer brown, since the height of the blue bar is about seven times that of the brown bar. Yet, the actual number of those preferring blue is not even one-and-a-quarter times the number preferring brown.

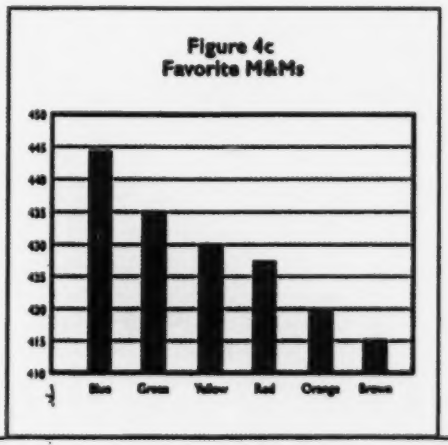
Students were asked to find examples of truncated graphs, write about why the graphs may have been truncated, and redraw them showing the entire y-axis. At first the students were amazed by how different the graphs looked with the entire y-axis. Their immediate reaction was to condemn the use of truncated graphs as misleading. However, after being prompted to look for legitimate uses of truncated graphs, they reconsidered. For example, they found that a nontruncated graph of the Dow-Jones averages could not show small day-to-day changes because the averages were all in the ten thousands. The students concluded that although truncated graphs are frequently used to mislead the reader, there are also legitimate reasons for creating truncated graphs.

If you want to try this activity, be aware that it is often time-consuming for students to locate examples of truncated graphs. You may want to use the examples provided in the textbooks listed in the reference section.

Activities that involve changing the scales of graphs naturally lead to discussion and conjecture, as students share their scaling choices and the resulting graphs. The process of choosing a real-life graph and then using the same data to construct a graph with a different appearance gives students a feeling of mathematical power. They enjoy the feeling of confidence that comes with successfully controlling the visual impact of a graph.







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Improving Literacy Through Innovative Professional Development for Teachers

Classroom teachers must be lifelong learners of mathematics and science if they are to help their students become truly literate in those areas.

by Mary Hindelang, Michigan Technological University, Houghton, Michigan

During the summer of 2000, when Michigan schoolchildren were enjoying one of the hottest summers on record, many of their teachers were working up a sweat at the Educators' Science and Mathematics Institute Series (ESMIS) at Michigan Technological University (MTU). Four intensive sessions were taught by Michigan Tech faculty, K-12 master teachers, and invited experts who presented an interdisciplinary approach to mathematics and science (see box).

At ESMIS, K-12 teachers become students; they relish the opportunity to explore, inquire, and discuss inspiring ideas with faculty and their peers. The experiential institutes are field- and laboratory-based and are designed with the *Michigan Curriculum Framework Standards and Benchmarks* as a guide. Assessment and evaluation of ESMIS are provided by the Center for Educational Technology, Research, and Assessment at MTU.

The institutes draw on three main resources—the expertise and innovative approaches of faculty and presenters who offer ideas that teachers can take back to their own classrooms; the experience and insight of the participants themselves; and reference materials, guidelines, and samples of award-winning teaching units that meet the Michigan standards. Supporting information from the humanities, social sciences, and related fields is woven into the courses, and sessions are devoted to reading critically and writing across the curriculum.

Goals Emphasize Both Pedagogy and Content Knowledge

Many of the goals of ESMIS focus on pedagogy. The intensive courses offer standards-based professional development that gives teachers time to plan, discuss, and reflect on their teaching. Follow-up during the school year encourages participants to integrate the new knowledge gained at the institutes into their classrooms, creating a culture of ongoing learning.

In addition to pedagogical goals, ESMIS concentrates on increasing the mathematical and scientific literacy of teacher-participants so they in turn can help their students build those literacies. To that end, ESMIS helps teachers and their students

- achieve a deep understanding of core concepts and theories of science, mathematics, and engineering through inquiry-based learning and problem solving;
- become familiar with the natural world and respectful of its unity, diversity, and fragility;
- concentrate on learning that is useful, relevant, and interdisciplinary;
- make informed judgments on statements or displayed data claiming to have a scientific basis;
- think scientifically and use knowledge to make decisions about real-world problems;
- reflect in an informed way on the role of science in human affairs;
- construct new knowledge for themselves through research, reading, writing, and discussion.

A Commitment to Active Engagement

Attendance at the institutes requires a commitment by participants to actively engage in all learning activities. Participants arrive prepared to present a session on one of their best teaching ideas to their professional peers. This activity has been one of the most valued in the institutes, illustrating the high level of expertise participants bring with them.

Throughout the institutes, participants focus on science and mathematics benchmarks for elementary, middle school, and high school. They work cooperatively in groups and have the opportunity to adapt their new content knowledge and skills into their specific educa-

In a culture increasingly pervaded by science, mathematics, and technology, science literacy requires understandings and habits of mind that enable citizens to grasp what those enterprises are up to, to make some sense of how the natural and designed worlds work, to think critically and independently, to recognize and weigh alternative explanations of events and design trade-offs, and to deal sensibly with problems that involve evidence, numbers, patterns, logical arguments, and uncertainties.

—Benchmarks for Science Literacy,
Project 2061, AAAS

tional level and situation, while sharing their teaching experience and ideas with other participants.

Each teacher-participant designs a teaching unit on a topic of her or his interest that models effective teaching strategies and meets the guidelines of state and national standards. Units include substantive content, teaching aids, handouts, and authentic assessment strategies.

At the conclusion of the institutes, participants share their preliminary ideas for teaching the unit and receive feedback from their colleagues. The teachers then implement the units during fall semester.

Ongoing Benefits

In November, MTU hosts a Teachers' Forum during which ESMIS participants share their teaching units, evaluate the implementation of their plan, and provide pre- and post-unit assessment data on their students. At the Forum they discuss things that worked and didn't work and how they would teach the unit in the future. Time is allotted so each teacher can answer questions and receive suggestions.

MTU developed a web site (www.ed.mtu.edu/esmis/index.htm) to showcase all of the units that have been

More About the Educators' Science and Mathematics Institute Series (ESMIS)

Funded by the Eisenhower Higher Education Grant Program, ESMIS provides graduate credit to help elementary, middle, and high school educators from across the state of Michigan integrate selected science and mathematics concepts into classroom teaching units. Here are brief descriptions of the institutes offered in 2000. See the contact information below for current information.

Ecology of the Great Lakes

This institute was based at Ford Forestry Center in Alberta, Michigan. Presentations and activities focused on the geology and ecology of the Lake Superior region and Isle Royale. Experts spoke on topics ranging from forest management to the Native American perspective on ecology to the use of GIS (Geographic Information Systems) in black bear research. Participants took a field trip to ecological sites of interest in the Keweenaw Peninsula.

Biology, Chemistry, and Biochemistry Institute

Also based at the Ford Forestry Center, this institute included presentations on diverse topics such as evolutionary biology, bacteriology, and forensic science. Participants had access to equipment for field and nature photography on a field trip to the Sturgeon River Gorge. Chemistry teachers learned about the latest technology for their classrooms, including spectroscopy. Physical, chemical, and biological effects of the Keweenaw current in Lake Superior were also studied.

Exploring Math and Engineering Institute

This institute was based on the Michigan Technological University campus. Session topics ranged from fluid dynamics to the physics of music. Use of high tech instruments allowed participants to study the seismic detection of tornadoes. Teachers made connections between engineering and the real world of their students and between mathematics and nature. One popular activity, bridge building and testing, included a field trip to study the bridges of Keweenaw County.

Space and Planetary Sciences Institute

Also held on the MTU campus, this institute began with fundamentals of astronomy and then progressed through a variety of astronomical topics, including human physiological adaptations to microgravity and mining extraterrestrial resources. Participants had the opportunity to use telescopes at the MTU Observatory and took a field trip to a Lake Superior beach to launch bottle rockets and high-altitude rockets.

For more information, contact:

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Visit the ESMIS web site: www.ed.mtu.edu/esmis/index.htm

Teachers need to view themselves and behave as members of a community working together for the benefit of its youth. The knowledge, skills, abilities, and attitudes required for this new vision of education and the roles of educators are simultaneously broad and deep. Like their students, educators must become lifelong learners, with the understanding that there will always be important things to learn.

—Susan Loucks-Horsley, et al.

improve mathematics, science, and technology literacy in their students.

Mary Hindelang is project coordinator of Educators' Science and Mathematics Institute Series at Michigan Technological University, Houghton, Michigan, where she also serves as a research assistant professor in the Department of Education.

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developed to date. (Editor's Note: Two articles in this issue of *ENC Focus* are based on papers written at ESMIS. See "Ecosystem Succession" by John Rosemurgy on page 39 and "Life and Times of a Bean Plant" by Tom Sprague on page 42.)

In addition to the units, the most valuable outcomes of the project are the bonds that have developed between K-12 teachers and MTU faculty. Many of the teachers have contacted faculty presenters for additional information or advice on content, or have invited them to be guest lecturers in their classrooms. In turn, university faculty have gained new perspectives through the experience of working with K-12 teachers and their students.

Thanks to the dedication of people from a broad range of disciplines, the ESMIS project at MTU is helping to transform the way that teachers are taught by providing high-quality professional development activities that deepen the teachers' content knowledge, foster mentoring relationships, and

The vision for mathematics education described in Principles and Standards for School Mathematics *is highly ambitious. Achieving it requires solid mathematics curricula, competent and knowledgeable teachers who can integrate instruction with assessment, education policies that enhance and support learning, classrooms with ready access to technology, and a commitment to both equity and excellence. The challenge is enormous and meeting it is essential.*

— Principles and Standards for School Mathematics, *NCTM*

Ecosystem Succession

Can students look at their environment and understand what they see? Being able to do so is an important aspect of scientific literacy.

by John Rosemurgy, National Park Service,
Keweenaw National Historical Park,
Calumet, Michigan

Like many other natural processes, ecosystem succession is a difficult phenomenon to grasp. One reason is that it happens so gradually. It may take as long as 1,000 years for succession to transform an ecosystem from the first or pioneering stage to the final or climax steady state. Over this time, plant and animal communities compete for resources in a tug-of-war. One species replaces another slowly through overlapping and transitional stages. Without disturbance, an ecological system will move toward steady-state conditions in which all species exist in balance, competing for the same resources—light, nutrients, and water.

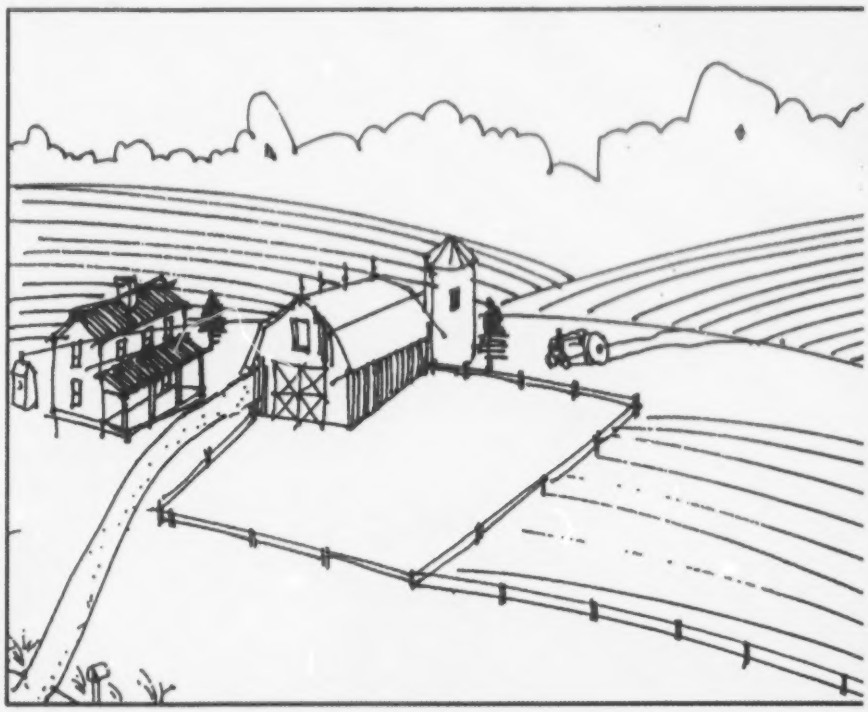
Given all of the variables (the variety of species and habitats) as well as the time required for the succession process to play out, it is a challenge to teach middle school students about succession. From their perspective, the world may seem established, unchanging—in sharp contrast to the roller coaster changes in their own lives. When students can advance beyond their self-centered view and begin to understand the pervasive and inescapable changes in the natural environment, they are taking a significant step toward scientific literacy.

Beginning with Students' Own Environment

As a participant in the Educators' Science and Mathematics Institute Series (ESMIS) at Michigan Technological University (see article on page 36), I developed a unit on succession for my students at Washington Middle School in Calumet, Michigan. The unit offered them the opportunity to understand ecological change by creating a series of pictures illustrating the process of succession. Students constructed the events themselves and related the ever-changing process of succession to places and ecosystems in their own environment.

Students in the Calumet-Laurium-Keweenaw schools have the unique experience of attending school within the boundaries of Keweenaw National Historical Park, where images and artifacts of the past abound. To begin the unit, Lynn Bjorkman, an historian with the National Park Service, visited the class to talk about the architectural and landscape history of the school site.

Using historic photos, Bjorkman showed how the site had been changed by the Calumet Hecla Mining Company over a span of 100 years. Her emphasis was on



1. The farm landscape depicts how agricultural practices can alter succession. Students might observe that the original ecosystem has been replaced with one introduced through human intervention. Teacher questions can help students notice some introduced plant species that may contribute to the future succession of the site, making it different from that which was originally present.

2. The lakeshore landscape illustrates the impact of homesteading and deforestation on a shoreline/wetland ecosystem. Students might predict that if succession proceeds uninterrupted, the pond environment will become absorbed by the surrounding native forest community.

how monumentally humans can impact the natural environment and alter the process of succession. One aspect of the presentation that students found particularly interesting was the original plans and photos for Agazzi Park. Today, the Copper King track and football field, Fraki's Supermarket, and subsidized housing—all familiar sites to students—occupy part of the original park.

The day following Bjorkman's visit, I distributed the current school site plan numbered to correspond with images from the slide presentation. Working in small groups, students used these primary references for clues in a kind of investigative scavenger hunt around the school grounds. This exercise illuminated the history of change in the built environment and also provided a visual perspective of how human activity shapes and changes the natural environment. These first two days were a jumping-off point for an introduction of ecosystem succession.

Adding Depth to the Learning

On the third day, students shared discoveries and questions about change and their environment. At this point, I introduced the concept of succession and assigned readings from books and from the web (see resource list). The focus of the readings was on primary succession—that which begins in areas that never supported living things, such as volcanic islands. The stages of pioneer, early, and, finally, climax succession were modeled for students with the use of overhead transparencies.

With this information, students were ready for the unit project assignment: to illustrate one example of the secondary succession process in the form of a booklet. Each booklet consisted of a picture of one of three familiar landscapes, a farm, a lake shore, and a mining site, illustrating a disturbance to the ecosystem brought on by either human or natural causes (see drawings 1-3). Three sheets of tracing paper were stapled on top of the picture.

The first step was for students to choose one of the three landscapes to work on. On the overlay directly on top of the picture, students drew how the landscape would look in the pioneer stage, zero to 50 years after the human or natural disturbance. On the second overlay students drew an illustration of the early successional stage, 50 to 300 years later, which is the transitional stage between the pioneer and climax community. Finally, on the third overlay, students would depict the climax stage, 300 to 1,000 years later.

Directions for creating the booklets were accompanied by a list of different plant species: pioneering plants, invasive plants, and climax plants. Field guides and graphic examples were also provided. In effect, students were expected to create the process of succession within a structured format.

As the work progressed, it became clear that learning would be enhanced if students wrote about their drawings. In class, we talked about the booklet pages as a kind of set design for a movie that takes place over a very long time. Students were asked to write a narrative for their "epoch-length movie set," including information about the changes in plant communities and animal habitat.

The booklets required several days of class time, and students were encouraged to work at home to complete the project thoughtfully. During the process, students also exchanged booklets and offered comments to their peers.

On the day the booklets were due, students completed a self-evaluation of their effort. They were asked to assess their collected images and reflect in writing on the positive and negative impacts for the environment.

For greater understanding, it may be beneficial for students to generate their own disturbance (fire, logging, mining) to an existing ecosystem rather than choosing from the three pre-disturbed ecosystems I created for them. Students may also want the option to depict the stages of primary succession, beginning where no ecosystems previously existed.

To add a technology component to the unit, students could be introduced to the Internet resources that provide data from the Geographic Information System (GIS) and

other scientific information about landscape. See the resource list at the end of this article.

Applying the Learning to Real-Life Problems

Following the completion of the students' booklets, the unit continued with an in-class brainstorming session on how humans impact the process of succession. We referred to the historic images that we used earlier. It was important for students to understand that succession is often influenced by human activity such as land filling, waste disposal, land development, road construction, farming, forestry, and even creation of wildlife sanctuaries.

Using a variety of sources including newspapers, the Internet, and magazines, students assembled a scrapbook of current examples of how human activity alters ecosystems. Students were introduced to the environmental movement through the work of groups and individual activists—and had the opportunity to respond via email to the ideas and opinions expressed.

To conclude the unit, students went on a field trip to a forested area where loggers have attempted both selective and clear-cutting of timber. Students had the opportunity to work in groups to make plots and plant surveys, take soil samples, pick cranberries, dissect pitcher plants, and witness succession taking place along the bog perimeter. They not only looked for evidence of succession in progress but also questioned the practices of best forestry management and land use.

The hope is that learning about succession gave students a better understanding of their surroundings and taught them how to be active participants in protecting and managing them. All of these are important for the development of scientifically literate citizens.

John Rosemurgy is currently historical architect for the National Park Service, Keweenaw National Historical Park, Calumet, Michigan. For five years, he was a middle school art and science teacher. This article is based on his experience at Washington Middle School in Calumet, Michigan.

Print and Web Resources

Heinrich, B. (1994). *A Year in the Maine Woods*. Reading, MA: Perseus Books.

Science Explorer (Prentice Hall) is a series of 15 books, each about a different topic. Of interest for the project described in this article are *Earth's Changing Surface* and *Environmental Science*. See related web sites:
www.phschool.com/atschool/science_explorer/index.html (books for younger students)
www.phschool.com/atschool/sci_exp_lep/index.html (books for older students)

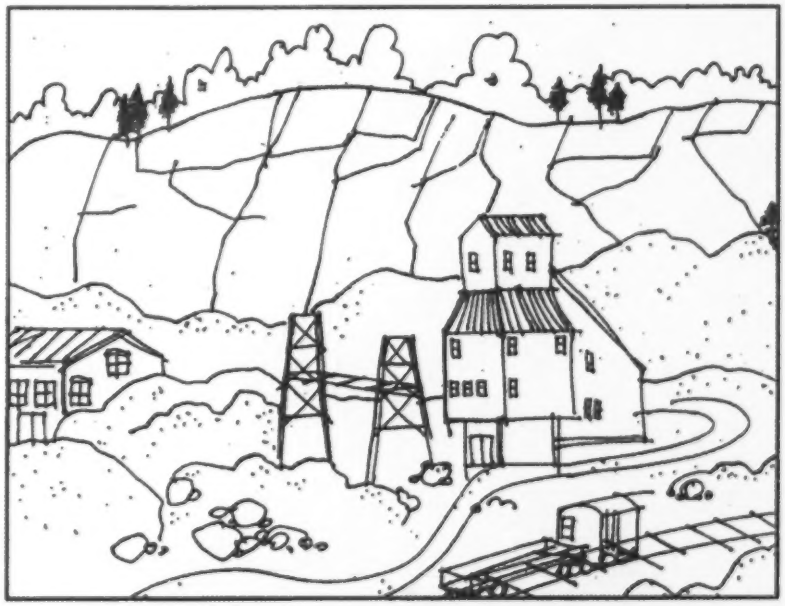
Community Change - Succession
wfscnet.tamu.edu
The Texas A&M University Wildlife and Fisheries page provides information about ecological succession.

GIS Forest Inventory and Analysis Model
www.forestry.mtu.edu/info/current/gisfia.html
This link provides information on the Geographical Information System (GIS).

Plant Succession: How a Field Becomes a Forest
www.env.duke.edu/forest/sucession.htm
This site has a black-and-white drawing of forest succession.

Adaptation and Succession: Unit Overview
www.scs.sk.ca/geo/Adaptation.html
This link includes ideas for lesson plans on climates, animals, and forests.

Old Growth, Musturi in Ruovesi 5 SW Finland
honeybee.helsinki.fi/users/korpela/old_growth_musturi_1.html
A photograph of old growth is provided on a web site maintained by a faculty member of the University of Helsinki.



3. The mining landscape shows an exposed cliff in the background; the foreground has been altered by copper mining. The rock piles are a result of many years of extraction. These rock surfaces are not covered by a layer of organic topsoil and will not allow plants to take root. Students might surmise that, at least during the next few hundred years, succession on this site will be limited to the spaces between rock piles rich enough in nutrients to support plant life.

The Life and Times of a Bean Plant

Kindergarten is not too early to develop the habits of mind that lead to a literate citizenry.

by Tom Sprague, Sullivan Elementary School, L'Anse, Michigan

As a participant in the Educators' Science and Mathematics Institute Series (ESMIS) at Michigan Technological University (see article on page 36), I developed a unit to promote scientific literacy in kindergarten students. I strongly feel that five year olds are ready to begin to use the scientific method and to learn to ask questions and form opinions.

The unit, The Life and Times of a Bean Plant, was developed when I was teaching in a rural area of upper Michigan. My students came to school every other day but remained for the full day rather than the typical half-day kindergarten session. This extended time allowed me to use thematic, interdisciplinary units in my teaching. It was also important for me to meet Michigan state standards and to cover many of the other skills kindergarten students need to prepare them for first grade—and for life. The sidebar provides samples of lessons from the unit along with standards met.

The activities were hands-on and presented in a way that was fun for the students. Lessons were nonthreatening; for example, when a seed did not germinate, the student was given another one to try. By giving the students an opportunity to correct mistakes, they were not afraid to fail. They learned that experiments don't always work the first time, and that is OK.

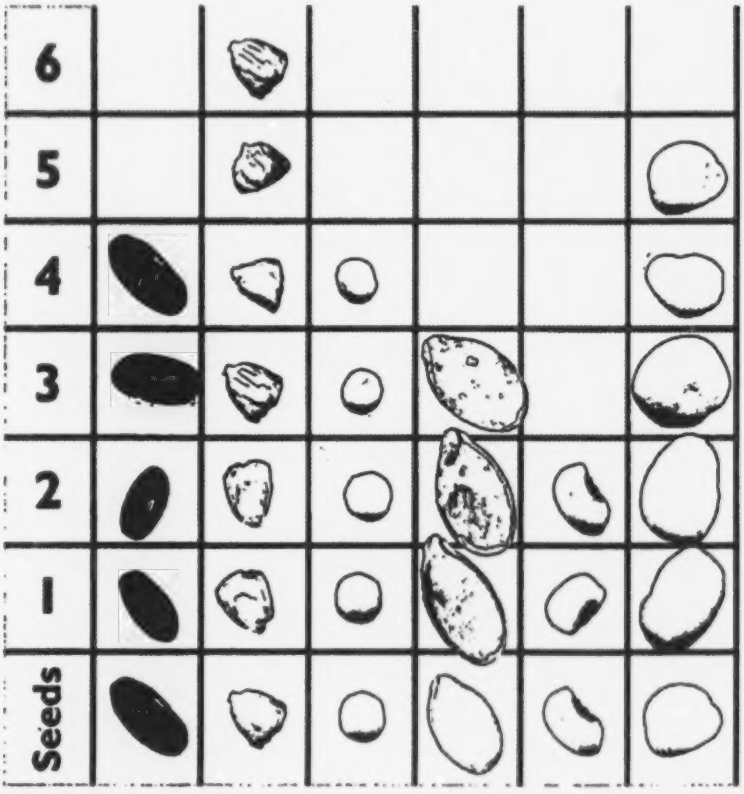


Figure 1. For a graph to use with your students, visit the online version of this article (enc.org/focus/literacy).

Walking and Talking and Math

I started the unit with a class discussion on the parts and life cycles of plants. Then we went on a walk through our neighborhood looking at plants and asking questions such as How do you know something is a plant? What kinds of plants are there? Where are plants found?

We spent a lot of time talking about what we saw while we were walking. This allowed me to see what the children already knew. When we returned to the classroom, I wrote down the students' experiences on chart paper as they told me about them.

The next step was the seed-graphing lesson, which I found on the Project Explorer web site of Arizona State University (see resource list). In teaching the lesson, I discovered that students are fascinated by different kinds of seeds. I gave them several minutes

to explore and manipulate the seeds plus plenty of time to sort different seeds into egg cartons.

As individual students finished sorting, I gave each child the opportunity to tell me why he or she sorted the seeds in a particular way. This exercise gave me some insight into each child's thinking.

The next activity gave students their first look at a bar graph. They matched their sorted seeds to the pictures along one axis of the graph and then glued the seeds onto the worksheet to make their own graph (see Figure 1). The class compared the graphs and discussed the information shown.

As a final activity, they also used seeds to make a picture.

More Than One Way to Grow a Bean Plant

One of the most enjoyable aspects of teaching kindergarten is observing the children's wonder at things that seem mundane to adults. Some kindergarten students may have had experience planting seeds in soil, but most will have no idea what happens when a seed wrapped in a wet paper towel is placed in a plastic bag. It was fun to watch their faces and listen to their comments when they unfolded the paper towel and saw a plant.

After planting the bean seeds two different ways, we spent the next several school days making observations. Since the students came to school every other day, they saw big changes. We looked at the plants that were in the wet paper towels, recording our observations of how they were growing. As the seeds in the towels began to sprout, the students were able to look at the roots and the development of the stem. We could also make inferences about what was going on with the seeds in the pots.

After a few days, we tested the students' predictions about what was happening to the plants grow-

Sample Lessons from the Life and Times of a Bean Plant

Seed Graphing Lesson

Materials needed for each student:

1. One plastic sandwich bag containing five or six kinds of large seeds such as corn, peas, beans, sunflower.
2. One egg carton per student
3. Graphing worksheet (Figure 1).
4. White glue.

Procedure:

Students sort their seeds into the egg carton compartments. Using the graphing worksheet, students glue their seeds in the appropriate boxes on the graph. Class members compare their graphs.

Interdisciplinary lesson extension: Art

Give each student heavy paper or cardboard, a variety of seeds, and white glue. Students glue seeds to the paper to make a picture or pattern.

Two Ways to Grow a Bean Plant

Materials needed:

1. Enough bean seeds to allow two for each student
2. Paper towels
3. Small plastic bags
4. Peat pots
5. Water
6. Tape
7. Pie pans

Procedure:

Each student soaks a paper towel in water, squeezes out the excess water, and folds the paper towel around one bean seed. Paper towels are then placed inside plastic bags, which are taped to windows away from direct sunlight. Next, each student soaks a peat pot in water to allow it to expand. The second bean seed is planted about 1 centimeter (1/2 inch) under the soil. Students place their pots in shallow pie pans, which are set on a sunny window ledge.

Standards Met

Michigan Content Standards for Science

Strand I, Content Standard 1.1
Generate reasonable questions based on observations

Strand I, Content Standard 1.6
Construct charts and graphs and prepare summaries of observations

Strand III, Content Standard 2.3
Describe life cycles (seed, flower, fruit).

ing in the pots. We took a few of the plants out of the pots and compared them to the plants in the wet paper towels. The children used their observations to answer such questions as What do plants need to survive? Our conversation led them to discover soil, water, light, and air.

As the plants in the pots continued to grow, students discussed what they had to do to take care of them. They also observed how the plants bend toward the light.

Photo: Jeremy Lundy

Making Connections

We extended our bean study by taking a closer look at other types of plants. In studying stems, we experimented by putting celery and carnations in colored water. Our study of leaves corresponded with autumn's changes in the trees outside our classroom. The children brought leaves back to the room so we could observe them more closely with hand lenses. We also used our collection of leaves to work on measurement, counting, and comparisons. For a fine motor activity, students folded a paper in half, then drew and colored a selected leaf in the top half, and glued the real leaf in the bottom half.

Our job is to prepare students for the future. The simple activities in this unit provide the students an opportunity to use the scientific method to observe, interpret, hypothesize. This approach to learning helps children form the habits of mind that they can use as they progress through the grades and that they can apply to everyday life. It is the foundation of literacy in mathematics and science.

Tom Sprague is currently principal of C. J. Sullivan Elementary School, L'Anse, Michigan. He taught fourth grade for seven years and also has experience teaching developmental kindergarten and regular kindergarten classes.

References and Other Internet Resources

Project Explorer at Arizona State University-West
coe.west.asu.edu/explorer/seeds.html

Observe a Leaf Lesson Plan by Shaleen Sullivan and Bridget Forest
askeric.org/cgibin/printlessons.cgi/Virtual/Lessons/Science/Botany/BOT0102.html

University of Tennessee-Martin "Kindergarten Science"

The general Kindergarten Science page:
www.utm.edu/departments/ed/cecs/kind.shtml

The first plant lesson—plant parts:
www.utm.edu/departments/ed/cecs/kinder/0F1.shtml

The second plant lesson—how plants grow and change:
www.utm.edu/departments/ed/cecs/kinder/0F2.shtml

San Francisco Unified School District K-5 Science Education
This site provides some additional ideas about kindergartners' growing and studying seeds.
nisus.sfusd.k12.ca.us/programs/cipd/science/k/kseedsweeds.html

University of North Texas: Science for the Elementary Grades
Here are several lessons for elementary grades about growing beans:
www.coe.unt.edu/luttrell/1stgrade/frist_grade_lessons.htm
www.coe.unt.edu/luttrell/3rdgrade/third_grade_lessons.htm
www.coe.unt.edu/luttrell/4thgrade/fourth_grade_lessons.htm

Texas Instruments
This site explains how a determined high school science class managed to get their experiment to take off—in a space shuttle.
www.ti.com/calc/docs/beans.htm

NASA
This page tells about an experiment conducted by American and Russian astronauts.
ccf.arc.nasa.gov/dx/basket/storiesetc/97_36AR.html

Here is a lesson designed to help students determine if seeds can be grown in space.
stellar.arc.nasa.gov/stellar/Activities/hydro/ShuttleMirSeedGerm/SeedGerm.html

This site explains the SEM-Space Experiment Module-and how to get your experiment into space, along with the program's history and current projects.
www.wff.nasa.gov/~7esapp/sem/sem.html

A Vote for Fidel Castro Is Not Truly a Vote Against Alison Peebles

We all want to make informed decisions as voters, but do we realize being truly informed requires us to become mathematically literate? This high school student's independent study illustrates the point.

by Alison Peebles, Albany Academy for Girls, Albany, New York

In many types of elections, several candidates are nominated for an office, the field is narrowed, the votes are cast, and the winner is proclaimed. Not everyone, however, is always happy with the results.

"Plurality winning is bunk!" "She didn't deserve to win." "I chose the person I thought would best do the job." These comments and others are often heard after elections, including the class president election at the Albany Academy for Girls. Following my defeat for 11th-grade class president, I decided to learn more about how I lost the election. I learned that there is more than one mathematical way to evaluate and manipulate data.

In this era of respect for diversity and individual worth, are we using the best mathematical method to elect candidates? Individual voters will always have a preference, but how are the preferences handled when election theory is based on discrete mathematics? Exploring election theories may offer alternative methods that can be substituted for the traditional routines employed in most elections. To be well informed, a voter must not only be knowledgeable about the candidates but also about the voting process and the mathematics behind the process.

Top Stops to Shop

Photos: Alison Peebles

Because of the emotions involved in class elections (and all politics), I evaluated voting mathematics in another type of situation. The Albany Academy for Girls student body has a passion for shopping, and all of the shoppers have their favorite haunts. I asked 100 girls to vote for their five "top stops" for clothing shopping, free of bias and with no selection reference.

Selection results indicate that student shoppers frequent many stores, but Old Navy received the most first-choice votes, 15 out of 100 in our population (see Table 1). In most elections, only first choices are counted; this is an example of the "single selection" method of voting. Old Navy was declared the winner because it received a plurality. If more than 50 shoppers had selected it as "first choice," Old Navy would also be declared the majority winner.

Plurality victories are not satisfying to many voters, and there is a mathematically viable alternative. In the 18th century, Count Jean-Charles Borda devised a method of preference voting that allows voters to select more than one option. The Borda Method assigns points to the choices, granting more points to the first choice than to the last choice. The points are then tallied,

Data Table 1

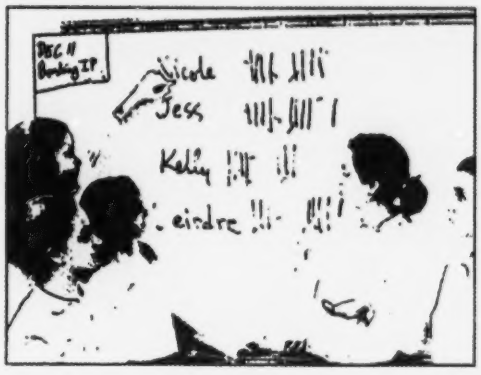
Store	1st choice votes	2nd choice votes	3rd choice votes	4th choice votes	5th choice votes
Old Navy	15	6	10	11	5
The Gap	13	23	13	11	11
American Eagle	8	16	10	5	9
Abercrombie & Fitch	13	10	10	7	5
J Crew	13	8	6	7	10

Data Table 2

Store	First choice votes	Borda Method preference points	Percent of representation
Old Navy	15	156	18.4
The Gap	13	229	27.8
American Eagle	8	153	18.8
Abercrombie & Fitch	13	154	17.6
J Crew	13	139	17.3

and the candidate with the most points is declared the winner. A candidate receiving a plurality doesn't necessarily "win" using the Borda Method.

In the data collected about my schoolmates' shopping preference, the Borda Method reveals that there is, in fact, a different winner, and it is not Old Navy. According to single-selection voting, The Gap came in second with 13 votes, but more people chose The Gap as a favorite place to shop overall (see Table 1). The Gap had the highest preference with 27.8 percent of the votes cast, while only 18.4 percent of the votes were for Old Navy. The Borda Method reveals that The Gap was the top group preference with 229 points, while Old Navy came in second with 156 points (see Table 2).



Both the single-selection method and the Borda method are mathematically accurate in their determination of the winner, but the results measure the winner in two distinct ways. If voters do not understand the mathematical tallying process used in an election, they may inadvertently give an advantage to a choice that they dislike. This is true for political elections as well as product marketing surveys.

Data Table 3

Name	1st Choice Vote (Single-Selection Method)	Group Preference Points (Borda Method)
Candidate A	3	31
Candidate B	1	43
Candidate C	5	38
Candidate D	2	37
Candidate E	3	19
Candidate F	3	19

Back to Politics

To test its application to a political situation, I used the Borda Method in conjunction with the single-selection voting method in the middle school student body elections at Albany Academy for Girls. Each grade voted for its own student council candidates. Only the single-selection preference was originally counted to determine election results, but analysis of the group- preference ranking allowed for a broader view of the vote.

Tables 3 through 5 represent the three grades in the middle school. Each class has more than 20 students, and each student voted. The possible candidates consisted of all of the students in the class. Only the candidates with the highest results are shown on the tables.

In Table 3, the difference between group preference and single-selection data is apparent. The "winner" of the single-selection vote is Candidate C with five votes, but Candidate B has the most preference points according to the Borda Method. It is important to note that Candidate B only received one first-choice vote. Although the candidate was clearly not many voters' first choice, she was the students' group preference.

In Table 4, both methods agree on the winner, Candidate I. If a runner-up needs to be determined, however, this count by two methods indicates that an additional vote must be conducted to determine the winner because of the discrepancy between the single-selection voting and Borda Method results.

In Table 5, Candidate L is the winner according to both methods, but more is known about the results of the election by using both methods of evaluation. The result of the single-selection voting tally does not indicate how similar the group's preference is for both candidates K and L.

These results show that the Borda Method can serve as an indicator of group preference and can be used

Data Table 4

Name	1st Choice Vote (Single-Selection Method)	Group Preference Points (Borda Method)
Candidate G	3	63
Candidate H	6	63
Candidate I	9	73
Candidate J	7	62

Data Table 5

Name	1st Choice Vote (Single-Selection Method)	Group Preference Points (Borda Method)
Candidate K	4	68
Candidate L	6	69
Candidate M	2	43

along with the single-selection voting system to show how a single-choice and multi-choice rating can be used together to better reflect the voters' intent.

Alternatives to Traditional Voting Methods

Electoral processes have relied on the single-selection method of voting for so long that implementing alternative methods may be nearly impossible, no matter how great the improvement in reliability or in the reflection of group preference in the outcome. Nobel Prize-winning economist Kenneth Arrow predicted conditions that would produce the most accurate way to determine preference. He provided five conditions, referred to as Arrow's Impossibility Theorem, that would allow for the most accurate determination of group preference. (See box.)

Although Arrow's conditions are mathematically best for attaining the true group ranking, he knew that having all conditions coexisting at the same time was impossible. The Borda Method meets four out of the five conditions; to date, this method is the closest to meeting Arrow's conditions, failing only at Unanimity.

This review of voting methods and the mathematics behind them shows how vital it is that voters be aware of how their choices are being evaluated. Through the controversies in determining the winner of the past presidential election, we have learned that every vote counts, but we must also consider how every vote is counted mathematically to be certain that we are accurately expressing our choice. To help make decisions that may improve our electoral system, voters must first become literate in the mathematics that supports different group-ranking methods.

Arrow's Impossibility Theorem

I. Non-dictatorship exists when choices are provided to form a group ranking; there must be more than one option from which to choose. If there were a dictator, there would be no choice and the preference of the dictator would overrule the preferences of the others.

II. Individual Sovereignty states that each individual is allowed to order his/her preference in any way. Termed politically, each man has the right to his own vote.

III. Unanimity states that if the group of individuals prefers one choice to another, the group ranking should reflect that preference. Furthermore, if the group ranking shows that one choice is preferred over another, all the individuals in the group should have the same preference.

IV. Freedom from Irrelevant Alternatives can be understood by considering choices A, B, and C. While comparing A and B to determine preference, C should have no influence on that preference.

V. Uniqueness of Group Ranking stresses that for each determination of preference in a group ranking, the method for doing so must be the same and that the preference must be able to be applied to something. Furthermore, if the method is continually applied the same way, it should always return the same results.

Alison Peebles, senior at Albany Academy for Girls, Albany, New York, is planning a math major in college. Influenced by the work of Kenneth Arrow, Alison believes that our current voting system needs to be changed, and she hopes to help alter it someday.

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Media Literacy: Yes, It Fits in Math and Science Classrooms

As teachers relate the significance of math and science learning to students' everyday lives, the role of the popular media adds another dimension to the discussion.

by Frank Baker, South Carolina ETV, Columbia, South Carolina

In 1992, a group of media educators gathered to discuss the state of media education. One of the results of their meeting was this definition of media literacy: "....the ability to access, analyze, interpret, and communicate media in a variety of forms...." (Aspen Institute Conference on Media Literacy).

Media literacy education now appears in the curriculum frameworks or standards of 48 states (Kubey & Baker, 1997). Media education fits quite well into the English/language arts curriculum, as well as social studies and health. But it is also applicable to mathematics and science. Media literacy is about inquiry: asking questions about the news and entertainment media, their makers and their messages. Media literacy is more than analyzing advertising, critical television viewing skills, or making videos with a camcorder. It is a lifelong skill designed to make students wise consumers, critical thinkers, and decision makers.

The Center for Media Literacy (a Los Angeles-based clearinghouse of media education materials) offers these five characteristics of messages delivered to the public via the media:

- All media messages are constructed.
- Media messages are constructed with creative language.
- Different people experience the same media message differently.
- Media messages are primarily driven by a profit motive.
- Media messages have embedded values and points-of-view (Thoman).

It is important that students understand these characteristics as they study media messages related to science and mathematics.

Connections to Science

The 1998 movie *Contact* starred actress Jody Foster as the scientist responsible for deciphering the first extraterrestrial message sent to Earth. The movie was generally applauded by scientists for its authenticity. But, it is rare for Hollywood to accurately portray a female scientist. Stereotypes and misconceptions are frequently generated by television and movie producers.

Stereotypes and misconceptions are frequently generated by television and movie producers.

Classroom teachers can take advantage of students' interest in popular movies to help them analyze the misconceptions. For example, both *Deep Impact* and *Armageddon* posed the question: What would happen if Earth were in danger of being hit by an asteroid or a large comet? Even though scientists tell us the chances of such a collision are small, these movies offer teachers an opportunity to explore how science is portrayed in these and other movies.

Every teacher who uses a video, a CD ROM, or the Internet as part of his or her instruction should ask questions such as this: How does the selection of images by the producer shape our understanding of science concepts?

Even the wealth of science programming by well-known documentary-makers should not be exempt from some inquiry on the part of teachers and students. Rather, the same questions that apply to commercial movies should also be asked of documentaries: who is the producer; what are his or her motives; what techniques does the filmmaker use to convey his message?

Len Masterman, considered one of the world's leading media educators, writes about curriculum connections in his book *Teaching the Media* (1985). He offers these ideas to consider when viewing or reading

popular media messages about science and scientists:

- the image, function, and status of science and scientists in the media (e.g., the use of scientists as experts in documentaries and advertisements);
- the scientist as hero (in dramas) or as madman (in much science fiction);
- the validity of scientific tests and principles used in advertisements (e.g., the replication of scientific tests or experiments);
- the integration of popular programs about science into the formal school curriculum;
- the conclusions drawn about scientific issues raised by the media and the scientific principles underlying the issues;
- the exploration of the different philosophies of sciences implicit in advertisements (science as verifiable fact) and documentaries (science as a fertile area of disagreement).

Connections to Math

Math and number literacy are parts of our everyday media exposure: the weatherman tells us there is a 30 percent chance for rain; the morning newspaper reports the stock market numbers; ESPN gives us statistics on sports.

Taking a close look at numbers in the news is a great way to get students to think about and question the source of statistics—and how statistics can be misrepresented. For example, each week, Nielsen Media Research issues its list of the top 100 television shows, based on the shows' ratings and shares. Do students know what rating and share really mean? How are these numbers generated? How are these numbers used by advertisers? Are the numbers accurate?

The advertising industry has been using numbers and statistics for decades. Many of us can remember when one brand of toothpaste made the claim that it was recommended by three out of four dentists. (What about the thousands of other dentists not surveyed?) A car commercial claimed the manufacturer's newest model gave a 30 percent smoother ride than last year's car. (How was smoothness measured?) Teachers can ask students to survey newspapers, magazines, and the Internet for ads that make seemingly outrageous or unsubstantiated claims.

Newspapers and magazines often use bar or pie graphs to visually display information. These graphical displays offer students another opportunity to analyze how data is portrayed and how accurate or misleading it may be.

Because so many students get their information from the media (television, radio, Internet) it is critical that teachers integrate media literacy into their instruction. Some of the sources listed in the sidebar are good starting points for teachers who want to learn more.

Frank Baker is a member of the Founding Board of the Alliance for a Media Literate America (formerly the Partnership for Media Education). He chaired the 1999 National Media Education Conference. Baker works for South Carolina ETV in Columbia, South Carolina.

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Media Literacy Education Resources

These web sites provide information and a broad range of resources about media literacy.

Alliance for a Media Literate America, formerly the Partnership for Media Education, is a membership group committed to promoting media literacy education. It stages an annual national conference on media education. Its stated mission is to mobilize teachers, parents, social service agencies, public health leaders, and others to support media literacy education. (www.AMediaLitAmerica.org)

Assignment: Media Literacy is a web site that provides K-12 curriculum materials. The site is designed in alignment with state curriculum frameworks in an effort to embed media literacy skills into such subjects as language arts, social studies, health education, and the arts. Samples of student work and teacher dialogues are available. (www.assignmentmedialit.com)

The Center for Media Literacy is a not-for-profit, membership organization located in Los Angeles, California. The center develops and distributes materials to schools and sponsors workshops and conferences. Founder and president of the center is Elizabeth Thoman, a former high school journalism teacher and publisher of a magazine about the media. The center offers a print and an online catalog of resources for teachers. (www.medialit.org/CML)

The Media Literacy Clearinghouse is a web site of background articles and lesson plans. It is funded by the state of South Carolina for the purpose of studying media literacy skills and health-related risks among young adolescents. (www.med.sc.edu:1081)

Media Literacy Online Project is housed in the College of Education at the University of Oregon in Eugene. On its web site are links to lesson plans, readings, indexes, and materials for parents. (interact.uoregon.edu/medialit/homepage)

PBS TeacherSource Web Site on Media Literacy gives classroom activities for language arts, social studies, math, science, and health. (www.pbs.org/teachersource/media_li/getting_started.shtm)

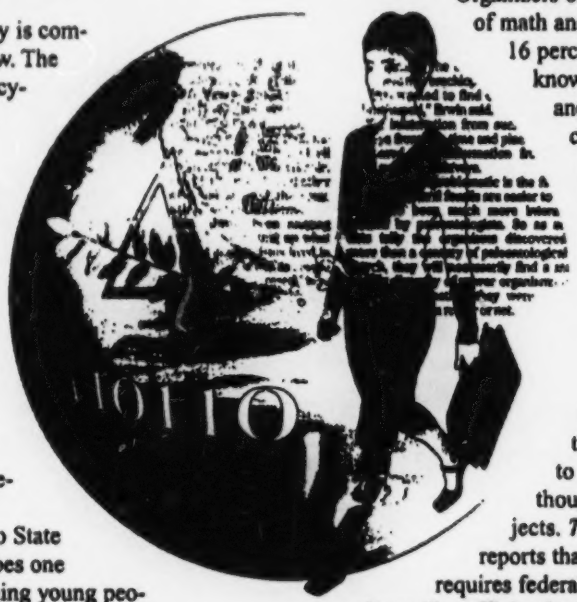
Math & Science Illiteracy in the News

Educators, mathematicians, and scientists would be wise to overcome misgivings about media coverage of complex math and science issues and recognize the role of the press in educating the public.

by Carolyn Hamilton, ENC Publishing

Time was when many of us could say, "Oh, I can't do percents" or "I never understood any of that genetics stuff" with no fear that anyone would think we were illiterate. The next generation will not get off so easily.

Math and science illiteracy is coming under the microscope now. The news media, politicians, policymakers, and educators warn that the need for math and science literacy is no laughing matter. Nor are the dire warnings of what will happen to the United States as a major player in the world if its people are not knowledgeable or at least conversant with fundamental scientific issues. A widely perceived need to equip all children with math and science competency is much in the news.



A recent article in an Ohio State University newspaper describes one professor's approach to reaching young people who take his Biology 101 course to fulfill a graduation requirement. Steve Rissing requires the nonbiology majors to subscribe to the *New York Times*. Weekly he assigns articles and gives quizzes. His intent:

> *I don't want to give my students a vocabulary test. I want to know if they understand some of the basic principles of science. . . One way to help give meaning to the jargon is to show relevancy, to show the students that science means something to their lives." (The Times Is A-changing, 2001)*

While newspapers can be a resource for enhancing literacy, they are also a source of warnings about the dangers of illiteracy.

The Oregonian (February 6, 2001), interviewed what it called "nonmath-related" professionals about their use of math on the job. The conductor of the state symphony said, "Math is the fundamental underpinning of all music, from understanding acoustics to reading music and figuring out tempo."

In the same article, a novelist recalled that he "fell off the train at story problems" and regretfully could not help his children with their math homework. A math specialist for the Portland schools reports that the district is being told by local businesses that math is "a gatekeeper of opportunity."

Organizers of an effort to spotlight the value of math and science education report that 16 percent of the U.S. adult population know the difference between a gene and a chromosome and thus can be called scientifically literate, according to an article in the *Washington Post* (In science, U.S. adults, 2000). Surprisingly, the researchers claim that this rate puts the United States in the top rankings worldwide.

Some people who tried to avoid math and science when they were in school find that they now have to play catch up to succeed in professions once thought far removed from those subjects. *The Christian Science Monitor* reports that the U.S. Supreme Court requires federal trial judges to determine if evidence "is sufficiently grounded in scientific principles to be introduced at trail. Many state courts have adopted similar standards." This has sent trial judges back to university campuses for summer courses in subjects as diverse as toxicology and statistics. There is even a nonprofit organization that educates judges about genetics.

The Washington Post points to actions by a Florida court justice in the infamous 2000 election recount trials that show he quoted but misinterpreted mathematician and author John Allen Paulos's comments about margins of error. (See article on page 24.) When the public suffers from math illiteracy, according to the reporter's

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conclusions, "Money is wasted, bad policy is made, health and physical risks are taken based on faulty information" (Strauss, 2001).

Educators would not be alone in their battle against illiteracy if Stanford faculty members Lucy Shapiro and Michael Riodan are successful in getting scientists to share their expertise with the news media. They believe scientists should overcome any misgivings about press coverage of complex scientific issues and join the press in trying to educate the public. Riordan says, "The press is the conduit to a large and influential audience." (*Science Daily Magazine*, 2001).

There's no denying that reporters will be highlighting the math and science literacy issue for some time to come. Teachers can take advantage of this attention to illustrate the relevance of mathematics and science to their students' lives. The classroom is also a good place to model ways to find and use accurate media coverage of new mathematics and science information.

Carolyn Hamilton is manuscript editor and news writer for ENC. A veteran journalist, she has written about educational issues for school library media specialists and school board members. Email: chamilton@enc.org

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Cloning and the Media: A Snapshot of Scientific Literacy

After our students leave formal schooling, they, like us, will learn about scientific breakthroughs from popular news sources. This survey looked at a number of implications of this relationship.

by Lynda C. Titterington & Suzanne Shaw Drummer, The Ohio State University

Ian Wilmut's announcement in 1997 that a lamb named Dolly had been cloned from an adult cell caused excitement among scientists and nonscientists alike. For weeks, the media bombarded the public with stories about the techniques, ethics, and implications of mammalian cloning. Then-President Clinton banned the use of federal funds for cloning research. Richard Seed, a physicist and entrepreneur, declared his intention to open a human cloning center. From embryonic cells, scientists cloned a second lamb, Polly, and a bull calf named Buster.

Most of us remember the newscasts, magazine covers, and newspaper headlines. For adults who have finished their formal education, this type of coverage is the primary source of information about such scientific breakthroughs, discoveries, and controversies (Mascazine, Titterington & Kalif, 1998; Callaghan, 1984; Moemeka, 1983; Ostman & Parker, 1986). Even scientific researchers reported that they first heard about Dolly through the radio or newspapers, the source of much of their information about breakthroughs outside their fields (Mascazine, Titterington & Kalif, 1998).

The influence of the media is not confined to adults. Despite some concerns about accuracy and sensationalism, teachers often assign articles from the popular press to engage youngsters in critical thinking about events and the coverage of them (Nardone, 1997; Morvillo & Brooks, 1997; Toby, 1997).

The *National Science Education Standards* (1995) recognizes the link between science literacy and the news media: "Science literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversations about the validity of the conclusions" (p.22). The extensive coverage of the first successful cloning gave us a unique opportunity to take a snapshot of this link.

We surveyed some 193 adults in four urban areas in Ohio and one rural area in North Carolina to determine what these readers learned from the coverage and what they retained. We also examined the media's efforts to inform the public about the science behind a major and complex accomplishment. Our research was designed to answer these questions:

- What facts about cloning were presented in popular periodicals and newspapers?
- Did popular periodicals and newspapers report the scientific facts of cloning accurately?
- What facts did the general public learn about cloning from the news media?
- What misconceptions about cloning persisted following media coverage?

Hello, Dolly!

People Weekly and *Life Magazine* ranked the cloning of Dolly the sheep among the top ten news stories of 1997. CNN ranked cloning second, after the Mars Pathfinder mission.

A search of the Newspaper Abstracts database on "cloning and Dolly" yielded 354 hits. In addition to regular newspaper coverage, Dolly the cloned sheep was featured in 294 publications, ranging from professional journals such as *Science* and *Nature* to trade magazines such as *Business Weekly* and *Popular Mechanics* to fashion and recreational magazines such as *Cosmopolitan* and *Esquire*.

Based on the results of our search, we examined more than 100 newspaper and magazine articles for the types of facts associated with journalists' five Ws: Who? What? When? Where? and Why? Specifically, we were looking for information about the scientists who conducted the experiments, where they worked, and the techniques they used to accomplish mammalian cloning from an adult cell.

We also examined the primary scientific literature to confirm the validity of the facts reported by these news publications. In addition, we were interested in discovering any commonly held misconceptions perpetuated by the mass media.

Dolly, Who?

We based our questions to adult readers on the cloning coverage in a variety of national magazines, such as *Time*, *Newsweek*, *People Weekly*, and *Popular Science*. The 30-item questionnaire surveyed participants on their comfort level with science, their primary sources of scientific information (the Internet, magazines, newspapers, television, or radio), and their reaction to media coverage of cloning in terms of clarity and accuracy.

A series of statements, derived from the headlines about cloning, allowed participants to rate the believability of the statements on a Strongly Agree (I've heard this and it's true) and Agree (I haven't heard this, but it sounds likely) to Disagree (I've heard this, but I doubt if it could be true) and Strongly Disagree (You've got to be kidding!).

A multiple-choice quiz based on well-publicized facts about cloning asked participants to identify Ian Wilmut, Richard Seed, and the country in which Dolly was cloned. Additional questions were designed to address some of the commonly held misconceptions about cloning by asking participants to predict the outcome of a series of scenarios in which people had been cloned. The veracity of the statements was confirmed by comparing them to primary research reports (Solter, 1998; Wilmut, 1997; Yoko, 1998).

What We Found

Accuracy of the Media

Overall the popular news media that we examined reported the facts of cloning fairly accurately. The errors we found were subtle and resulted from oversimplifying complex biological information.

For example, several articles made a claim to the effect that "...every cell in the body has the instructions to make a complete human" (Lemonick, 1998, pp.64-65) or "... every cell contains the entire genetic code, but the code is only 'active' as the being is forming" (Little Lamb, 1998, p. 60). According to Discover Magazine, "An adult's body cells all share the same DNA" (Caldwell, 1999, p. 56). For the most part, these statements are correct, but they are also somewhat misleading. None of them accounts for the haploid variation generated through meiosis.

The most frequently encountered error was in the reported success of Wilmut's experiment. Wilmut explained that Dolly's embryo was produced from one of 277 trials, but the news reports varied from 277 to 400.

How People Use Media Sources

Our respondents told us that they frequently used magazines and the Internet to obtain science information. *Newsweek* and *Popular Science* were the most common choices for science news.

Nevertheless, they didn't express great confidence in their knowledge of the cloning. Only 43 percent reported that they felt confident enough about their knowledge to be able to discuss cloning with friends; 20 percent indicated that they knew enough to vote on the cloning issue; and 27.5 percent rated their knowledge of cloning as limited.

In spite of their reliance on the news media for science information, most respondents felt that the media provided unclear explanations of scientific topics. They were ambivalent in their opinions of media accuracy, calling it either slightly inaccurate or mostly accurate in coverage of cloning.

What People Retained from Media Coverage

We found that many of our survey respondents failed to retain the basic facts that were prominent in coverage of the cloning. Less than half (43 percent) of our respondents recognized that Ian Wilmut was the scientist who cloned Dolly. Even fewer (35 percent) understood that Dolly was unusual because she was cloned from a cell taken from an adult mammal.

In addition, approximately half of our respondents adhered to some commonly held misconceptions about cloning: that clones "appear" as fully mature organisms (instead of a fertilized egg); that a cloned organism can

be easily distinguished from "noncloned" organisms; and that clones somehow develop at a faster rate than organisms created the "old-fashioned way."

Feature writers' tongue-in-cheek articles may have contributed to some of the misconceptions we discovered. For example, *Cosmopolitan* featured an article titled, "Cloning Men! Why Weird Science Will Quadruple the Great Guy Supply" (Brown, 1997), and an article in *Parenting* recommended a self-cloning kit (Satran, 1997). Both writers played on the misconception that the product of cloning is an adult who will possess the same personal attributes as the cell donor—in these articles, attractiveness as a mate and ability to be a good parent.

Our findings indicated that the respondents' choice of media type and magazine preference made a difference in the amount they learned about cloning. Those who used radio, newspapers, and magazines as science information sources had similar scores: approximately 25 percent of them answered more than eight of the 13 cloning questions correctly. Only 13 percent of those who relied on television news and 8 percent of the Internet users were able to answer eight or more questions correctly.

The Mass Media as Curriculum?

Contrary to our expectations when we began our study, we found that accurate information on a major scientific event was available through the news media. Before the study, we had avoided using news articles in the classroom. We now believe we should use media resources to teach our students how to locate errors when they occur and how to find reliable sources among the wealth of publications available.

The fact that our respondents didn't retain much of what they read or heard is another concern for those considering use of media reports in the classroom. Our results indicate that retention is related to the source of information. Reports from television and radio news are remembered the least, and print information is remembered slightly better. These factors can be taken into consideration when choosing sources from the popular media to use in class.

Finally, we feel it is important to remember that the news media in its many forms—television, radio, newspapers, and web sites—serve as the public's teacher. As educators, we can help our students to learn to use news media reports appropriately as a primary source of lifelong learning in science and technology.

Both Lynda Titterington and Suzanne Drummer are veteran science educators. This article is based on a presentation they made at the 1998 Annual Meeting of the National Association for Research in Science Teaching (NARST) in San Diego, California.

Cloning in the News

See the online version of this article (enc.org/focus/literacy) for a list of magazine articles illustrating the accuracy, misconceptions, and variety of coverage of cloning. A selection could be used for classroom study of media coverage of scientific breakthroughs.

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Math on the Map

Combining math with writing and social studies can help students attain a higher level of literacy in all three areas.

by Wendy Cheely, Hilltonia Middle School, Columbus, Ohio

Amy Moore, a fellow teacher, and I decided to use journaling in our classrooms to help students express themselves creatively as well as to prepare them to answer short response and essay questions on the Ohio Sixth Grade Proficiency Test.

We prompt students with word problems not only in math but also in science and citizenship. For this article, we are focusing on math prompts that rely on information learned in science and social studies. In this way, we are constantly reminding the students that no concept that they learn is practiced in isolation.

When we evaluate the students' responses, we look for:

- clarity of expression including correct vocabulary, complete sentences, focus, and details,
- logical expression using the operations taught to solve problems,
- comprehension of the concepts being taught, and
- retention of "old" concepts by their application to new situations.

If any of these aspects are missing, we write notes in the student journals about how to improve. We question how they did what they did, or, if the problem is really severe, we ask them to see the teacher.

The accompanying journal entries are by students of varying abilities and backgrounds. I have included my comments on each entry.

Photo: Linda Baker

Wendy Cheely (left) and Amy Moore

The Assignment

The students were to read a map and determine the distance from one point to another using the map's scale. The students were given problems that required multiple conversions, both division and multiplication. My evaluations revealed that several students had difficulty connecting the first conversion with the second.

Problem 1. It is 20cm on your map from Sydney, Australia, to Tokyo, Japan. The scale for your map is 4cm = 500m. How far is it from Sydney to Tokyo? Explain how you got your answer.

Ruth's answer:

The answer is 2,500 miles. How I got my answer was I looked at the scale number and it said 4cm = 500 miles. So I divided 20 by 4. And I got 5. So I multiplied 500 times 5 and I got 2,500.

Teacher's comment:

Ruth,

You have a good understanding of how to read a map to find distance. In your explanation, you told me why you divided but did not explain why you multiplied. Please add that explanation to your journal entry.

Tammy's answer:

This is how I got 20 because they said every 4 = 500 miles so I add the 4 until it added up 20 then I counted how many fours I had then I did 15 × 500. Thats how I got my answer.

Teacher's comment:

Tammy,

You have shown that you understand how to find distance on a map. You used a method that was different from most students but that's OK because there is more than one way to solve the problem.

Dick's answer:

I played with the numbers and messed around on the back of my paper to get my final answer. By dividing 20 by 4 I got the number 5. Then I multiplied 5 × 500 and the answer was 2,500.

Teacher's comment:

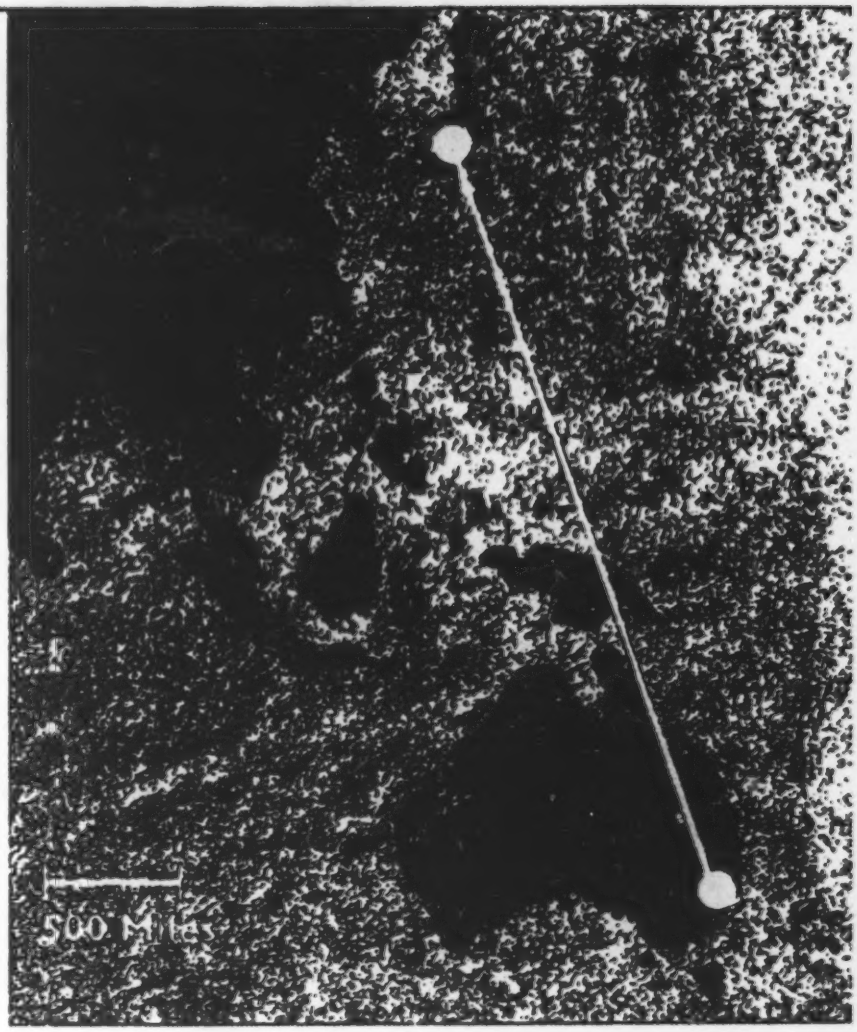
Dick,

You did get the right answer to the problem, but I am not sure that you or I understand how you got your answer. Please see me so that we can talk about your journal.

Problem 2. Tripoli measures 18 cm from New Delhi. The scale for the map that you are using is 3 cm = 500 km. How far is it from Tripoli to New Delhi? Explain how you got your answer.

Jamie's answer:

I knew that there was 18 cm from New Delhi to Tripoli and that I needed to find two numbers that can be multiplied together to get 18. I found the the numbers 6 and 3 equalled 18. Then, since I had 18 cm, I had to multiply 6 by 500. After that, I converted 9,000 cm into .9 km by placing a decimal at the right of the ones place. I counted over 4 spaces because of km being 4 to the left of cm on a chart. I divided 3 into 18 because I knew I needed to find out how many 3's there are in 18 to find out how many scales I had.



Teacher's comment:

Jamie,

It looks like you know the steps to complete the conversion, but you confused the scale length in the first conversion. And I'm glad that you remember how to convert cm to km, but this problem doesn't need that conversion because the scale does it. See me if you have questions.

Kenny's answer:

I got 3,000. I saw how many times 3 can go into 18. I had to do it because every 3 cm = 500km so I put down six 3 and multiplied all of the 3's and 6 × 500 because every 3cm = 500km

Teacher's comment:

Kenny,

You used a different approach to the problem, but that's OK because there is more than one way to find the answer to the problem. You have clearly shown how you found your answer using the scale.

Latisha's answer:

Answer is 3,000. Multiply 3 times 6, then you take it and you divide. Then you add up
500 + 500 = 1,000 + 1,000 + 1,000 = 3,000 and you divide it by 3. Then you get your answer.

Teacher's comment:

Latisha,

You came up with the right answer, but I don't understand how you got your answer. Your explanation is unclear. Please see me so you can explain how you did the problem.

Wendy Cheely teaches mathematics at Hilltonia Middle School, Columbus, Ohio. She serves on ENC's Teacher Advisory Group.

Putting Textbooks to the Test

Project 2061's evaluation of textbooks identifies the qualities and features that help all students learn the ideas and skills that make up mathematics and science literacy.

by Jo Ellen Roseman, Gerald Kulm, and Susan Shuttleworth, Project 2061, American Association for the Advancement of Science

In the United States, textbooks have an enormous influence on what is taught in K-12 mathematics and science classes and how it is taught. Research shows that a majority of teachers use textbooks as their principal curriculum guide and source of lessons (St. John, 2001). New and inexperienced teachers, or those who lack adequate time for lesson planning, may actually teach from the first page of the textbook to the last, skipping little or nothing (Tyson, 1997).

Since this is the case, it is imperative that textbooks provide the right content and instructional support. Texts must cover the key mathematics and science ideas that students need for literacy in those areas. Texts also must provide research-based instructional strategies that teachers can use to help students learn those ideas.

In 1998, after developing and field testing a rigorous procedure for analyzing curriculum materials, Project 2061 of the American Association for the Advancement of Science applied the procedure to middle- and high-school textbooks to see how well they align with standards and how well they help students achieve them. This study probed beyond a superficial analysis of alignment by topic heading and examined each text's quality of instruction aimed specifically at key standards and benchmarks, using criteria drawn from the best available research about what helps students learn.

The results were eye opening. Out of 45 texts analyzed (13 middle-grades mathematics texts, 12 algebra texts, 10 middle-grades science texts, and 10 high school biology texts) only five (four middle-grades math texts and one stand-alone physical science unit) were found to be satisfactory, that is, having a high potential for helping students learn ideas that are essential for mathematics and science literacy. Seven of the algebra texts were borderline, considered barely adequate for learning. The rest of the math and science texts were found to be unsatisfactory with little potential for helping students learn important ideas and skills. Visit the Project 2061 web site (www.project2061.org) for a list of the books examined and an explanation of the analysis procedures.

What's Wrong with Today's Texts?

In 1964 the Nobel Prize-winning physicist Richard Feynman reported on his experiences as an advisor to a California textbook selection committee: "...something would look good at first and then turn out to be horrifying.... (the books) said things that were useless, mixed-up, ambiguous, confusing, and partially incorrect. How anybody can learn science from these books, I don't know, because it's not science." Many of these problems remain.

Today's textbooks cover too many topics without developing any of them well. Central concepts are not covered in enough depth to give students a chance to truly understand them. While many textbooks present the key ideas described in national and state standards documents, few books help students learn the ideas or help teachers teach them well. For example, Project 2061's analysis of high school biology texts revealed the following problems:

- Research shows that essentially all students—even the best and the brightest—have predictable difficulties grasping many ideas that are covered in the textbooks. Yet most books fail to take these obstacles into account in the activities and questions.
- For many biology concepts, the textbooks ignore or obscure the most important ideas by focusing instead on technical terms and superfluous detail—the sorts of material that translate easily into items for multiple choice tests.
- While most of the books are lavishly illustrated, these representations are rarely helpful because they are too abstract, needlessly complicated, or inadequately explained.
- Even though several activities are included in every chapter, students are given little guidance in interpreting the results in terms of the scientific concepts to be learned.

Project 2061's evaluation of textbooks also helped identify what works—those qualities and features that help all students learn the ideas and skills that make up science and mathematics literacy.

Characteristics of Effective Materials

Project 2061's evaluation organized the instructional characteristics of effective materials into seven broad categories and rated the materials against specific criteria within each category. Examples drawn from the highly rated *Connected Mathematics*, a series developed for grades 6 through 8, and *Matter and Molecules*, a stand-alone physical science unit developed at Michigan State University, provide some examples of what effective materials do in a few of the instructional criteria categories:

Taking Account of Student Ideas

To help students gain a better understanding of key concepts and skills, textbooks need to help teachers attend to the ideas that students already have, both ideas that are incorrect and those that can serve as a foundation for subsequent learning.

Every investigation in *Connected Mathematics* has a section called "Teaching the Investigation," which helps the teacher identify ideas that students may bring to the lesson and offers suggestions on how to address these ideas. The text also reminds teachers of prerequisite knowledge and skills at the beginning of most investigations. For example, before students make parallelograms from triangles, they are reminded of an earlier unit that taught that triangles have rigid structures.

Matter and Molecules lists relevant misconceptions that have been reported in student learning research, explains each one and why it makes sense to many students, and describes how students who hold the misconceptions are likely to respond to probing questions. This helps teachers diagnose their own students' learning difficulties.

While some textbooks have notes in the teacher's guide labeled "Misconceptions" or "Prior Knowledge," these statements often provide little useful information. If teachers (or perhaps even the textbook developers themselves) are unaware of common student misconceptions, then it will be hard to plan effective instruction.

Project 2061's Curriculum-Materials Analysis Procedure

Project 2061's analysis procedure was developed over a three-year period in collaboration with more than 100 scientists, mathematicians, educators, and curriculum developers, with funding from the National Science Foundation. The analysts examined the texts' quality of instruction aimed specifically at the key ideas using the criteria drawn from research about how students learn.

For a complete explanation of the criteria and evaluations, visit the project web site (www.project2061.org).

Visit the electronic version of this magazine (enc.org/focus/literacy) for direct links to the 2061 site and all sites mentioned in this issue

Engaging Students with Relevant Contexts, Experiences, and Phenomena

Much of the point of studying mathematics is to appreciate the range of ideas and applications the ideas can model. To help students gain this kind of appreciation, *Connected Mathematics* uses a variety of contexts—from visual models to symbolic representations of hands-on activities and firsthand experiences—to build formal ideas and skills. Number experiences include using fraction strips, cooking, using thermometers and number lines, and exploring consumer issues. For algebra, students are engaged in data collection and using graph paper and calculators. In the geometry units, they use area models, grid paper, rulers, and square tiles.

In science, students need opportunities to relate the concepts they are studying to a range of phenomena either directly or vicariously. *Matter and Molecules* engages students in directly observing physical science phenomena and reading vivid descriptions of other phenomena related to the kinetic molecular theory:

- When air is compressed in a syringe, it pushes back on the plunger.
- Gases (like perfume) spread out evenly in a room or container.
- Liquids (like food coloring or tea) spread out evenly in a glass, rather than falling to the bottom.

These experiences help students see how the idea that "atoms and molecules are perpetually in motion" offers a plausible explanation for the phenomena.

Promoting Student Thinking About Phenomena, Experiences, and Knowledge

For optimal learning to take place, textbooks also need to help students make sense of their experiences and ideas. Textbooks that provide carefully chosen and sequenced questions and tasks can help students reflect on, clarify, and explain their reasoning and ideas.

To help students understand what it means for figures to be mathematically similar, for example, *Connected Mathematics* engages students in using a rubber band to make enlargements of drawings. As they work on the investigation, students are asked to consider which figures remain the same or change when a figure is enlarged, to compare how the figures differ from one another, and to explain their judgments.

Connected Mathematics routinely emphasizes the need for students to explain their answers, ideas, and solutions with the class or small group. It also provides teachers with suggestions on how to engage students in class discussion. A self-assessment page at the end of each unit encourages students to think about what they've learned.

Matter and Molecules provides question sequences to help students interpret their activities. The questions are structured carefully to lead students step-by-step from one insight to another. Questions frame important issues, help students relate their experiences with phenomena to the scientific ideas presented, or prompt students to contrast common misconceptions with their scientific alternatives. For example, to help students think about how molecules are arranged and move in liquids and gases, *Matter and Molecules* asks students to consider the following questions as part of an activity in which they push air and water in and out of a syringe:

1. How far apart are the molecules of a gas compared to a liquid?
2. In which of these two states of matter do you think it would be easier to push the molecules together? Why?
3. Below is a drawing of a syringe. How would molecules of air be arranged in the syringe when the plunger is all the way out? Draw the air molecules in the syringe.

Students then compare their predictions to what actually happens. They push on a sealed plunger that is filled with water and observe that it does not compress. They replace the water with air and repeat the experiment, this time finding that they can push on the plunger. In each case, questions ask them what happened and why:

4. Can you push the plunger in when the syringe is filled with water?
5. What happened when you tried the same experiment but filled the syringe with air?
6. Why can you push the plunger in when there is air in the syringe, but not when there is water in it?
7. Why can't you push the plunger all the way in with air in it?

Students are reminded to talk about molecules in their answers. Then they are asked to observe what happens when they push on and then release the plunger in the syringe filled with air. The question helps them relate the phenomenon to the idea that molecules are constantly moving. Another question relates the phenomenon to the scientific idea:

8. Explain why the plunger moves back out.

Later in the unit, students are asked a question that anticipates a common misconception—that molecules are not perpetually in motion but only move if the substance appears to move:

> If you let this cup [of sweetened tea] stand overnight, would the sugar rise to the top, settle to the bottom, or spread evenly throughout the water? Talk about molecules to explain your answer.

Developing and Using Scientific and Mathematical Ideas

Textbooks need to provide a wide range of problem-solving and practice tasks to help students see the link between concepts and skills.

Connected Mathematics provides a real-world scenario or story line that builds students' understanding. For example, the text challenges students to plan a bicycle touring business. Students develop bar graphs and charts predicting the costs involved, depending on the number of cyclists and the distance of the tour. They write equations that can predict travel times and profits under varying conditions. Students develop and work with their own data, so they can explain the relationship among variables.

Matter and Molecules provides practice tasks for most of the physical science ideas it examines. These include novel tasks that ask students to develop descriptions and explanations of phenomena they see all around them. Their explanations are expected to become increasingly sophisticated as their understanding deepens.

For example, the following questions (taken from several places in the unit) have students move from using the idea that "molecules are in perpetual motion" to combining it with other related ideas:

- Draw pictures to show how water molecules are moving.

- Can water molecules in ice slow down and stop?
- If you want something to dissolve fast, should you mix it with hot water or cold water? Why?
- Explain how you can smell an open bottle of vinegar even though you are across the room. What is actually reaching your nose? How did the vinegar molecules get into the air? How did the vinegar molecules reach your nose?
- When food is covered with plastic wrap in the refrigerator (or when soup is warming on the stove, but not boiling, with a lid on the pot), water evaporates and then condenses. Where does the water evaporate from? Where does the water condense? How do the water molecules get from the place where water evaporates to the place where water condenses?

In contrast, most science textbooks include few, if any, relevant practice questions. Instead, they rely on multiple choice or short answer questions that simply require students to find the correct answer from similar statements that appear a few pages earlier.

Implications for Literacy in Mathematics and Science

With the wide acceptance of national and state standards and benchmarks in science and mathematics, there is growing optimism about educational improvement:

> *In a field where fads have ruled, we are seeing something new: a growing commitment to the idea that clear and shared goals for student learning must provide a foundation on which to improve education and achievement. Without clear goals, we cannot succeed, for we cannot know in which direction to move.* (Stigler & Hiebert, 1999)

But as Project 2061's evaluations have shown, mere alignment is insufficient if students are to actually learn and remember key ideas—materials also must support teaching and learning the ideas. Publishers, authors, funders, and others involved in creating textbooks—along with the educators who use them—must commit themselves now to producing a new generation of textbooks that will help all students achieve these goals. And just as important, teachers need to have carefully targeted professional development that will enable them to appreciate the strengths of highly rated materials and use them well.

In the meantime, schools and school districts can use the evaluation reports to make well-informed adoption decisions. Teachers who have already selected highly rated materials can use the reports to better understand their textbook's strengths. Teachers who have not been able to select highly rated materials can use the reports to identify their textbook's strengths and weaknesses and then focus on supplementing their text with stand-alone units or trade books or with lessons from other textbooks that do a better job. They can use Project 2061's instructional criteria to guide their own classroom instruction and can study the research on student learning that is cited in the reports and use it to revise learning activities and develop new ones. And, finally, they can take advantage of professional development experiences that focus not only on increasing their knowledge of key ideas in science and mathematics, but also on strategies for teaching those ideas more effectively.

Jo Ellen Roseman is associate director of Project 2061, Gerald Kulm is Curtis D. Robert professor of mathematics education at Texas A&M University, and Susan Shuttleworth is a writer and editor with Project 2061.

Beginning in 1985, Project 2061 has worked to reform science education in grades K-12 so that all high school graduates become science literate—that is, prepared to live interesting, responsible, and productive lives in a world increasingly shaped by science and technology. The initiative has developed a variety of tools and training for educators to support efforts to translate the established learning goals into classroom activities. Project 2061's textbook evaluations have been funded by the Carnegie Corporation of New York. More detailed information regarding the evaluations can be found at the project's web site (www.project2061.org).

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Focus on the Collection

This section presents highlights from the full ENC record for exemplary resources selected to illustrate this issue's theme.

ENC's Collection and Catalog

ENC's collection of mathematics and science resources is the most comprehensive in the nation. More than 19,000 resources are housed in our national repository, with new items arriving daily. We collect materials from federal and state agencies, commercial publishers, professional organizations, school districts, and individuals. The collection includes print materials, software and CD-ROMs, kits and manipulatives, along with hundreds of excellent Internet sites.

All materials are cataloged by ENC, and the catalog records are searchable from our web site (enc.org). Part of each catalog record is a detailed description of the resource written by ENC experts in mathematics and science education. These descriptions are not evaluative reviews, but the online record does include references to reviews, awards, and other evaluative materials.

Developing Literate Citizens

by Carol Damian and Terese Herrera, ENC Instructional Resources

As information becomes ever more quantitative and as society relies increasingly on computers and the data they produce, an innumerate citizen today is as vulnerable as the illiterate peasant of Gutenberg's time. (Steen, 1997)

Today's young people will, as adults, greatly influence what life on earth will be like [in the future]...Being literate in science is a condition for doing so responsibly, as well as for living a full and meaningful life. (AAAS, 1993)

Our information-driven world bombards us with volumes of quantitative and scientific data, requiring all of us to weigh evidence, detect fallacies, evaluate claims, assess risks, and make decisions based on our understanding of the mathematical and scientific concepts involved. How successfully we make those decisions depends on how literate we are in general math and science. *Science for All Americans* (1989) states that being an informed, literate citizen today means to:

- understand how the scientific endeavor works and how science, math and technology relate;
- view the world of nature and the role of humans in it;
- grasp conceptual knowledge about science, mathematics, and technology in the context of history and the themes that cut across all fields;
- and acquire inquisitive minds to be critical participants in the affairs of the world (AAAS, p. 2).

The implications for education are clear and fundamental, although certainly not easy to address in the classroom. This issue of *Focus* offers a selection of resources to support teachers in addressing today's broadened definition of literacy.

In looking for resources to include in this issue, we thought in terms of skills needed to function in society, such as "making sense of numbers" and "understanding science news and issues." We kept in mind that teaching for mathematical and scientific literacy needs to be consistent with the spirit of inquiry, which means that these materials involve students in investigating problems, collecting and analyzing data, constructing meaningful understanding of abstract concepts, and relating students' work to decision-making scenarios.

We also selected resources for professional development. These include the introductory selections on the meaning of literacy and the background reading materials. Other resources listed among the skills categories support teaching those skills.

We found that there are many ways to describe what it means to be mathematically and scientifically literate. For this Collection Section, we have chosen to emphasize resources that highlight relevant instruction and learning. While we are not able to feature here all of the literacy-related resources available from the ENC Collection, we do hope that the selection of materials will be useful to you as you strive to help all students in your school become literate in mathematics and science.

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Featured Resources

Defining Math and Science Literacy

64 Atlas of Science Literacy (K-12)

64 Principles and Standards for School Mathematics (preK and up)

64 National Science Education Standards (K-12)

65 Benchmarks for Science Literacy (K-12)

65 Inquiry and the National Science Education Standards: A Guide for Teaching and Learning (preK-12)

65 Why Numbers Count: Quantitative Literacy for Tomorrow's America (1 and up)

66 Innumeracy: Mathematical Illiteracy and Its Social Consequences (preK and up)

66 Young People's Images of Science (4-11)

66 Every Child a Scientist: Achieving Scientific Literacy for All (K-12)

66 The Glossary of Mathematical Mistakes (9 and up)

67 Designs for Science Literacy (K-12)

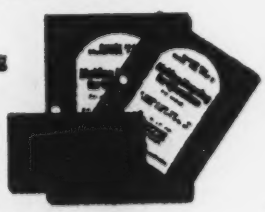
Making Sense of Numbers

67 Supporting Mathematical Development in the Early Years (preK-1)

67 Growing Mathematical Ideas in Kindergarten (K)

67 Developing Number Concepts, Book 2: Addition and Subtraction (K-3)

68 Number and Operations, Part 2: Making Meaning for Operations (K-6)



68 Making Numbers Make Sense: A Sourcebook for Developing Numeracy (K-8)

68 Living and Learning Mathematics: Stories and Strategies for Supporting Mathematical Literacy (1)

68 Learning Through Problems: Number Sense and Computational Strategies, A Resource for Primary Teachers (1-3)

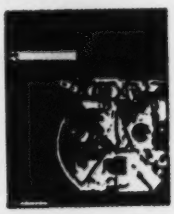
69 To Half or Half Not: Fractions, Decimals (2,3)

69 Developing Number Sense (3-6)

69 Mathwise: Teaching Mathematical Thinking and Problem Solving (3-6)

70 How Math Works (3-8)

70 Teaching Fractions and Ratios for Understanding: Essential Content Knowledge and Strategies for Teachers (3-8)



70 Developing Mathematical Imagery: Activities for the Classroom (6-12)

71 Exploring Symbols: An Introduction to Expressions and Functions (7-12)

71 Say It With Symbols: Algebraic Reasoning (8)

71 Powers of Ten: A Film Dealing With the Relative Size of Things in the Universe and the Effect of Adding Another Zero (9-12)

Organizing and Analyzing Data: Graphing

72 The Graph Club With Fizz & Martina (K-4)

72 Tracking Graphs (6,7)

72 Graphing (7-12)

Organizing and Analyzing Data: Statistics

72 Teach-Stat Activities: Statistical Investigations (3-6)

73 Exploring Statistics in the Elementary Grades, Book 2 (4-8)

73 Data: Kids, Cats, and Ads (5)

73 Data Analysis and Statistics Across the Curriculum (9-12)

74 Exploring Data (10-12)

74 Internet Projects for Elementary Statistics (10 and up)

74 Misused Statistics (10 and up)

Organizing and Analyzing Data: Probability

75 Probability (1,2)

75 Chances Are... Part 1: Probability (3)

75 Probability (4-6)

75 Chance and Data in the News (7-12)

76 Chances of a Lifetime: Probability (7-12)

Applying Mathematics

76 A Money Adventure: Earning, Saving, Spending, Sharing (K-3)

76 Investing for Kids (1 and up)

76 Neale S. Godfrey's Ultimate Kids' Money Book (3-8)

77 A Blueprint for Geometry (5-8)

77 Mathematics of Cartography (5-12)

77 In the Wind (6-8)

78 Stock Market Simulations (6-9)

78 Geometry Activities from Many Cultures (6-10)

78 Math in Daily Life: How Do Numbers Affect Everyday Decisions? (6-12)

78 Six Billion and Beyond: Population in the New Millennium (6 and up)

78 A Problem of Life and Death: The ECMO Saga (7-12)

79 Mathematical Modeling: Using Graphs and Matrices (9-12)

79 Mathematics for Decision Making in Industry and Government: High School Modules (9-12)

79 Real-World Math With the CBL System: Activities for the TI-83 and TI-83 Plus (9-12)

80 Mathematics in Biology (11 and up)

64

Applying Science

80 Family Learning Events: Science and Math Activities Through a Literacy Approach (K-4)
80 MAD Labs (K-12)
81 Ethics and Values in Pre-College Science Instruction (K and up)
81 Population Growth and Balance (5-10)
81 Decisions, Decisions (6-12)
81 Waste Management (7)
82 Chemistry That Applies, 8th, 9th, or 10th Grade (8-10)
82 BioBlast: Better Learning Through Adventure, Simulation, and Telecommunications (8-12)
82 Your Genes, Your Choices: Exploring the Issues Raised by Genetic Research (9-12)
83 PhysLINK.com: The Ultimate Physics and Engineering Reference and Education Online Source (9 and up)

Understanding Science News and Issues

83 Computers, Teachers, Peers: Science Learning Partners (preK and up)
83 Beyond 2000: Science Education for the Future—A Report with Ten Recommendations (K-12)
83 The Why Files: Science Behind the News (K-12)
84 Science and Creationism: A View from the National Academy of Sciences (K and up)
84 Living and Working in Space: The Countdown Has Begun (3-10)

84 Talking About Sex: A Guide for Families (5-9)
84 Technology and Science for a Safer Tomorrow (5-9)
85 The Food System: Building Youth Awareness Through Involvement (5-12)
85 Issues, Evidence & You (7-9)
85 Chemistry Connections (7-12)
85 The Weather Book: An Easy-to-Understand Guide to the USA's Weather (7-12)
86 Cloning: How and Why (8 and up)
86 Genetic Engineering: A Reference Handbook (9 and up)
86 Genome Gateway News (9 and up)
86 Chances' Choices (10-12)

Creating Scientific Awareness of the Environment

87 Habitats of the World (K-5)
87 A Sense of Place: Teaching Children About the Environment with Picture Books (K-6)

87 Island Explorers Marine Science Program (1-8)
88 Oceans (2, 3)
88 Rain Forest (2-4)
88 How the Weather Works (3-8)
88 Communities in Nature (4-6)
89 Animal Interdependency (5-8)
89 Eyes on the Sun (5-9)
89 Oceans (6-8)
90 Biodiversity! Exploring the Web of Life (6-10)
90 The Birth of Earth and Ancient Oceans (6-12)
90 Energy Conservation: A Student Audit of Resource Use (6-12)
91 The Insect World (6-12)
91 American Plastics Council (7 and up)
91 Environmental Science: Earth As a Living Planet (10 and up)
91 Water on the Web (10 and up)

Placing Science Learning in Context

91 Teaching Young Scientists, Grades K-1: Curriculum Linked Integrated Units (K-1)
92 Enhanced Science Helper (K-8)
92 Resources for Science Literacy: Professional Development (K and up)
92 Book of Science Questions That Children Ask (1-6)

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98 Tools for Understanding: A Resource Guide for Extending Mathematical Understanding in Secondary Schools (7-12)

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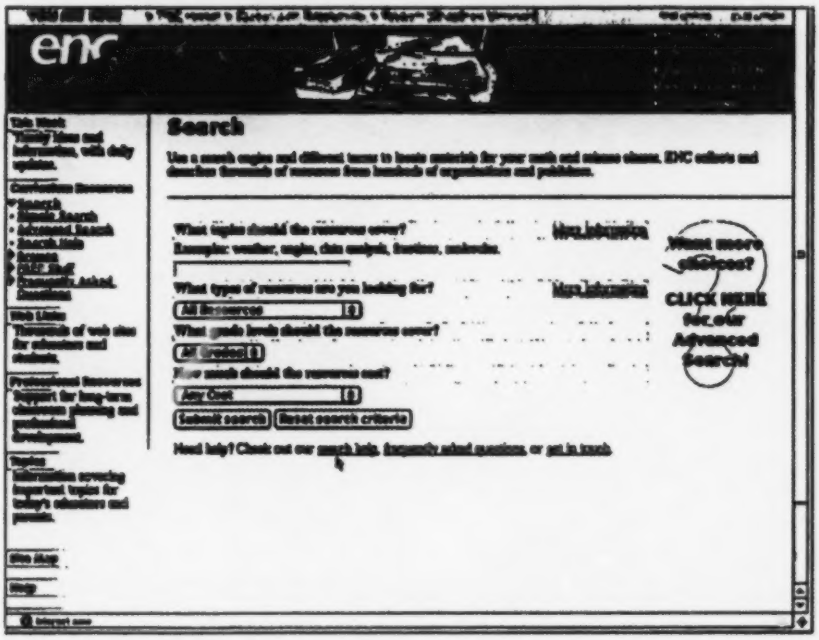

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For example, materials for this issue were found through the use of subjects such as decision making, critical thinking, real world, STS (science, technology, and society), ethics, and applied mathematics.

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Atlas of Science Literacy

Grades K-12
2001
Author: Project 2061

The *Atlas* presents a collection of strand maps that show the development of students' understanding of the ideas and skills that lead to literacy in science, mathematics, and technology. Each strand map focuses on a topic important for literacy and displays for all grade levels the benchmarks that are most relevant to understanding it. For each benchmark, the text indicates measures that should have been met by the student and those that will need to be met later. The book also includes discussions of strand maps in general and information directly related to each individual map. Every chapter includes clusters of closely related maps that loosely correspond to sections in *Benchmarks for Science Literacy*. Each map is accompanied by commentary that includes a general discussion of the topic at hand, a brief summary of the content of the map and its major strands, and remarks on related themes, historical episodes, or topics that have not yet been mapped. The second part of the map commentary highlights interesting or difficult aspects of the map and provides relevant research. The final chapter provides information on how the idea of strand maps originated and how they were constructed. A reference table shows how each of the benchmarks is distributed throughout the strand maps. (Author/SSD) ENC-018882

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Principles and Standards for School Mathematics

Grade preK and up
2000
Author: National Council of Teachers of Mathematics Writing Group

The National Council of Teachers of Mathematics developed this volume to be a resource for all who make decisions that affect the mathematics education of students in preK to grade 12. Built on NCTM's previous three standards documents, *Principles and Standards for School Mathematics* (*PSSM*) presents a vision of school mathematics based on the belief that all students should learn important mathematics concepts and processes with understanding. *PSSM* is divided into six principles and 10 standards. The six principles for school mathematics describe the particular features of a high-quality mathematics education and address overarching themes: equity, curriculum, teaching, learning, assessment, and technology. Each principle is discussed in detail in terms of the vision for school mathematics developed in *PSSM*. The 10 standards for school mathematics are descriptions of what mathematics instruction should enable students to know and do. The five content standards are number and operations, algebra, geometry, measurement, and data analysis and probability. The five process standards are problem solving, reasoning and proof, communication, connections, and representation. All standards are presented by grade bands for preK to grade 2, grades 3-5, grades 6-8, and grades 9-12. The standards define the mathematics that all students should have the opportunity to learn as they progress through the grades. Each standard comprises a small number of goals that apply across all grades, with the content standards offering an additional set of expectations specific to each grade band. The presentation of the standards is highlighted with examples of student work and examples from the classroom told in the words of teachers. The Table of Standards and Expectations in the appendix highlights the growth of expectations across the grades. It presents a concise summary of expectations related to each content standard arranged by grade band. Also in the appendix is an overview summary of expectations for the preK-12 process standards. References are included. (Author/JRS) ENC-017582

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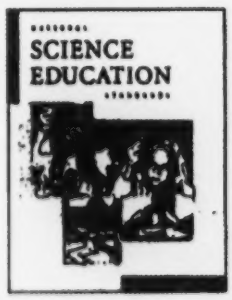
National Science Education Standards

Grades K-12
1996
Author: National Research Council



The *National Science Education Standards* present a vision of a scientifically literate populace. They are guided by the following principles: Science is for all students; learning science is an active process; school science reflects the intellectual and cultural traditions that characterize the practice of contemporary science; and improving science education is part of systemic educational reform. The standards describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, and in which supportive educational programs and systems nurture achievement. Topics covered include science teaching, professional development, assessment, science content, science programs, and systems. The document also describes the conditions necessary to achieve the goal of scientific literacy for all students, including opportunities for students to learn and for teachers to teach. The standards for teaching focus on what teachers know and do. The standards for professional development focus on how teachers develop professional knowledge and skill. The science assessment standards are criteria against which to judge the quality of assessment practices and can be used as guides in developing assessment practices and policy. The standards for content define what the scientifically literate person should understand and be able to do after 13 years of schooling. These standards, organized by grade clusters, define content to include inquiry; physical, life, and Earth sciences; connections between science and technology; science in personal and social perspectives; the history and nature of science; and unifying concepts and processes. The program

standards, which provide criteria for judging the quality of and conditions for school and district science programs, focus on issues at the school and district levels that relate to opportunities for students to learn and opportunities for teachers to teach science. The science education system standards provide criteria for judging how well the system provides schools with the financial and intellectual resources necessary to achieve the national standards. Samples and vignettes are provided throughout the document. References are provided for each standard. (Author/KSR) ENC-006101

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Benchmarks for Science Literacy

Grades K-12
1994
Author: Project 2061, American Association for the Advancement of Science

Project 2061 is a long-term initiative of the American Association for the Advancement of Science to reform K-12 education in natural and social science, mathematics, and technology. This book, a companion to *Science for All Americans* (SFAA), provides benchmarks of what all students should know or be able to do in science, mathematics, and technology by the end of grades 2, 5, 8, and 12. The last section describes how the book was developed and presents research findings on students' learning difficulties for the recommended topics in the book. Each chapter includes general comments on the ideas to be learned and the kinds of student experiences that would foster learning. Also included is a section introduction that comments on common learning difficulties, pacing over grade levels, and clarification of the ideas themselves. In every chapter are references to correlations in other chapters, information on what students' experiences at different grade spans might include, and what difficulties students might have. The disk version (DOS) enables readers to browse through the book, assemble and print selected collections of benchmarks, and use cross-reference features to identify conceptual connections. (Author/CCC) ENC-001752

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$24.95 per disk

Inquiry and the National Science Education Standards: A Guide for Teaching and Learning

Grades preK-12
2000
Author: National Research Council

The first of the planned addenda to the *National Science Education Standards* (*NSES*), this guide was written to discuss the meaning and multiple roles of inquiry in the classroom. The book also summarizes the research that argues for the value of inquiry in science education and identifies what actions need to be taken to support inquiry in the classroom. The National Research Council developed this text to improve teaching and learning, explain and promote inquiry-based methods, and guide scientists' work with teachers. The guide describes where inquiry is found in the NSES, discusses classroom assessments, and answers frequently asked questions about inquiry methods. Vignettes of teachers and students engaged in and learning about inquiry are used to illustrate ideas in the text. The appendices elaborate on excerpts from the NSES and explain how to use worksheets when selecting instructional materials that promote inquiry. Black-and-white photographs throughout the book show students involved in scientific inquiry. The guide contains a bibliography of resources for teaching science through inquiry. (Author/JR) ENC-017490

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Why Numbers Count: Quantitative Literacy for Tomorrow's America

Grade 1 and up
1997
Author: edited by Lynn Arthur Steen
Publisher: College Entrance Examination Board

The essays collected in this book explore quantitative literacy from many perspectives, discussing what quantitative literacy is, why it is important, why it is a problem, and how to address the problem. Several themes are addressed, such as the ability of quantitative literacy to empower people (and of quantitative illiteracy to disempower), quantitative literacy in the workplace, and educating for quantitative literacy. A concluding chapter examines the differing perspectives of mathematicians and mathematics educators. Contributions include essays from Gina Kolata of the *New York Times*, an interview with Shirley Malcom regarding mathematics as an equalizing force, and an essay by Henry Pollak of Teachers College, Columbia University, on real-world applications of problem solving. A recommended reading list suggests sources for further exploration in related areas of mathematics and education in general. (Author/RMK) ENC-012658

Note: Many excerpts from the above text are available at a web site titled Numeracy and Quantitative Literacy (www.stolaf.edu/other/extend/Numeracy/numeracy.html).

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Innumeracy: Mathematical Illiteracy and Its Consequences

Grade prof. and up
1990
Author: John Allen Paulos

This book, written by a mathematician, aims to construct a sense of numerical proportion and an appreciation for the probabilistic nature of life in a society where innumeracy (the mathematical equivalent of illiteracy) is dominant. The author cites the technological nature of society as the reason for the need for a population that is numerically and scientifically literate. The book explores reasons for the perverse pride people feel in mathematical ignorance and includes dozens of examples of how innumeracy can adversely affect life choices in not only personal economics and travel plans but also mischosen mates, inappropriate drug testing, and the allure of pseudoscience. The author uses a debunking tone to describe the lack of numerical perspective, exaggerated appreciation for meaningless coincidence, credulous acceptance of pseudoscience, and inability to recognize social tradeoffs that are found in society. The mathematical approach throughout the book uses elementary ideas from probability and statistics that require only arithmetic and reasoning. (Author/JRS) ENC-014531

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Young People's Images of Science

Grades 4-11
1996
Author: Rosalind Driver, John Leach, Robin Millar, Phil Scott

This book presents the results of a major study into the understanding of the nature of science by students ages nine to 16. The authors argue that an understanding of science goes beyond learning the facts, laws, and theories of science. Instead, it involves understanding the nature of scientific knowledge and the relationships between science and society. The study examines the ideas students form about science as a result of their experience in and out of school. It also explores how science teaching might develop a more scientifically literate society. Finally, it also investigates how students understand disputes about scientific issues, including those of social significance, such as the irradiation of food. The results of the study indicate that school science has limited success in promoting these understandings. The book concludes with a discussion of how the school science curriculum could be adapted to better equip students as future citizens in a scientific and technological society. (Author/LCT) ENC-011670

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Every Child a Scientist: Achieving Scientific Literacy for All

Grades K-12
1998
Author: Committee on Science Education K-12 of the Center for Science, Mathematics, and Engineering Education (CSMEE)

Developed for parents and others who want to improve their school's science program, this booklet explains why high-quality science education is important for all children and young adults. The first section argues that science should be a part of all students' education. The second section envisions the curriculum and teaching in a classroom where students can gain the understanding of science and technology that they need in today's society. Sections three and four outline how the *National Science Education Standards* (1995) can help improve the quality of the science being taught and how it is assessed. The booklet suggests what readers can do to become partners in improving science teaching and learning. (Author/LT) ENC-012129

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The Glossary of Mathematical Mistakes

www.mathmistakes.com
Grade 9 and up
1998
Author: Paul Cox
Publisher: Planet Systems Network of America, Inc.

This web site contains explanations and examples of common mathematical mistakes made by advertisers, the media, reporters, politicians, activists, and many non-math people. Visitors will find mistakes given humorous names, such as: Aftermath Counting, which explores the tendency to inflate figures after a major disaster; Factorectomy, which is the failure to account for factors such as inflation that vastly affect the outcome; and Astrology Amnesia, which is the tendency to forget three weeks of wrong predictions when a prediction is correct. There are examples of each mistake and explanations of thought processes that produced the errors. In one example, Bogus Graphs, the site shows how optical illusions can be used to make insignificant data seem significant. This site also includes a readers' response page, puzzles and problems with solutions, and links to related web sites. Winner, ENC Digital Dozen, November 1998. (Author/JRS) ENC-013627

Designs for Science Literacy

Grades K-12
2000
Author: Project 2061

In this book, the goals of Project 2061 are extended by focusing on curriculum design. The focus is on how to design complete K-12 curricula that result in scientifically literate students. The text considers the application of general design principles to curriculum and envisions how curriculum can be designed using various high-quality instructional blocks. Suggestions are given for ways to improve an existing curricular framework. One chapter, Building Professional Clarity, discusses the need for faculty science literacy. It uses a strand map to explain the development of students' science thinking. Methods are suggested for aligning instructional topics with benchmarks. Also included are tips for understanding student learning goals, becoming familiar with research on learning, and improving assessment practices. A supplementary CD-ROM contains a complete, searchable full-text version of the book, a compilation of resources for additional information, and databases for customizing curriculum plans. (Author/JG) ENC-018937

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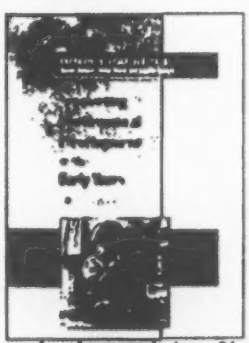
Making Sense of Numbers

Supporting Mathematical Development in the Early Years

Series: Supporting Early Learning
Grades preK-1
1999
Author: Linda Pound



Part of the Supporting Early Learning series, this book is intended to help parents, teachers, and other early-years educators understand and facilitate children's mathematical development. The author stresses the importance of recognizing the earliest precursors to successful mathematical achievement and building upon those to promote interest in and enthusiasm for mathematics. The first chapters give an overview of young children's mathematical behavior and examine the characteristics of learning in the early years that positively influence all future learning. Further chapters outline issues in effective curriculum design and implementation. The concluding chapters concern the roles of teachers and parents in developing children's learning and contain suggestions for promoting partnership in this area. (Author/MM) ENC-018377

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Growing Mathematical Ideas in Kindergarten

Grade K
1999
Author: Linda Schulman Dacey, Rebeka Eston

The vision in this book paints a picture of a kindergarten classroom that nurtures students' mathematical understanding. The authors provide specific guidelines for how to create such a classroom environment, including how to plan for a full year of teaching and learning mathematics. Guidance is given on how to choose mathematical tasks and assess understanding. Many samples of student work are included to illustrate what children are capable of doing with mathematics. Appendices provide references for using children's literature and 25 favorite books for supporting mathematics instruction in the kindergarten classroom. (Author/JAR) ENC-017212

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Developing Number Concepts, Book 2: Addition and Subtraction

Series: Developing Number Concepts
Grades K-3
1999
Author: Kathy Richardson

This textbook, one of the three-volume series Developing Number Concepts, is designed to develop number concepts in addition and subtraction. It consists of a rationale for the series as well as yearlong lesson plans and teaching materials for each grade. The series espouses the principles that children develop an understanding of concepts through experiences with real things rather than symbols, and that for children to be engaged, they need to be on the edge of their understanding or level of competence. Each chapter in this book offers background information on the topic, goals for student learning, and teaching suggestions. The teaching suggestions take the form of classroom scenes in which sample lessons on topics are reported in detail. The rest of the chapter provides two types of activities: teacher-directed activities and independent activities. In the activity The Snap It Station, for example, two students work together. One makes a train of six connecting cubes and shows it to the other student. The first student then hides the chain behind his/her back and breaks off part of it, showing the first student how many were broken off. The second student then writes the equation to show how many are left: for example, $6 - 4 = 2$. Students can check their answer by looking at how many cubes are left in the chain. The partners then repeat the activity for a wide range of numbers under 10. (Author/MM) ENC-018090

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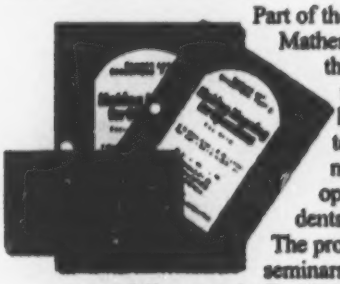
Number and Operations, Part 2: Making Meaning for Operations

Series: Developing Mathematical Ideas
Grades K-6
1999
Author: Education Development Center, Inc. (EDC)



Part of the Developing Mathematical Ideas program, this professional development kit is designed to help current and future teachers explore the meaning of arithmetic operations and how students develop these concepts. The program offers field-tested seminars, typically presented over a full year and offered at regularly scheduled intervals, that examine the "big ideas" in elementary school mathematics. Seminar materials include a facilitator's guide, a casebook for each participant, and a video that shows students working in classrooms organized around student thinking. For this seminar, the participant's book contains 28 cases that explore the ways students come to understand addition, subtraction, multiplication, and division. The casebook is divided into chapters that correspond to the eight sessions of the seminar. The introduction to each chapter describes the set of cases, highlights the general mathematical themes they address, and provides questions to consider while reading the cases. At each session, participants discuss the cases and engage in a related mathematics activity designed to challenge adult learners. In the course of the sessions, participants look at and discuss innovative curriculum materials, consider research findings related to mathematics education, and create and discuss a portfolio of their assignments. References are included. (Author/JRS) ENC-018073

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Making Numbers Make Sense: A Sourcebook for Developing Numeracy

Grades K-8
1994
Author: Ron Ritchhart
Publisher: Addison-Wesley Publishing Company

Teachers of elementary and middle school students can use this sourcebook to help develop numeracy, or mathematical literacy. The text consists of instructional guidance, lessons, blackline masters, suggestions for authentic assessment, and ideas for schoolwide projects. Author Ritchhart seeks to encourage positive attitudes toward mathematics and develop student competency by establishing a context for the use of numbers. The book emphasizes the connections between the strands of mathematics and students' active construction of meaning. Ritchhart advocates having students explore concepts through hands-on materials and examine their own reasoning and the reasoning of others. Each lesson is identified by the mathematical strands covered and the material required. This is followed by a description of the lesson in terms of its conceptual and instructional level, the purpose of the lesson, the preparation required, and extension activities. In the activity Place-Value Hockey, for example, students practice adding large numbers by placing strips labeled 10, 100, 1,000, 10,000, and 100,000 in random order on a table at six-inch intervals. Students then flick colored counters over the strips and accumulate points according to the numeric value shown on the strip covered by the counter. Students have 10 turns each and then add up their scores. (Author/MM) ENC-018391

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Living and Learning Mathematics: Stories and Strategies for Supporting Mathematical Literacy

Grade 1
1998
Author: David J. Whitin, Heidi Wilde, Timothy O'Keefe

The stories and strategies in this professional development book document how mathematical literacy was developed in a first-grade classroom. The authors use pictures and samples of student work to illustrate the mathematical activities of 20 students. Children are shown devising strategies for problem solving and thinking mathematically as they use numbers in meaningful ways. They also create stories, discuss strategies, and assemble their own numerical information as they measure plants, classify dinosaurs, and count new and missing teeth. This book is organized around significant issues that are helpful in understanding how children learn mathematics. It is designed to provide guidance in developing a curriculum that is consistent with children's learning process. Issues include how literature fits into the mathematics classroom and how to make graphs meaningful. Children's interests, questions, and observations are used to guide the mathematical discovery process and to shape the curriculum. The resulting curriculum invites children to use mathematics and language as tools for learning in an environment supportive of mathematical literacy. References are included. (Author/JRS) ENC-015101

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Learning Through Problems: Number Sense and Computational Strategies, a Resource for Primary Teachers

Grades 1-3
1999
Author: Paul A. Trafton, Diane Thiessen

Elementary teachers can use this resource book to learn about problem-centered learning, an approach to mathematics instruction that honors children's thinking and sense-making ability. The approach weaves elementary mathematics top-

ics—including addition, subtraction, place value, and problem solving—into a variety of contexts that allow for genuine mathematical exploration. The first part of the book demonstrates this approach through classroom activities and outcomes resulting from using the Pizza Problem Story. The Pizza Problem Story illustrates what the authors term the four characteristics of a good problem: challenging nature, accessibility for all students, existence of various solution strategies, and worthwhile mathematical ideas. In the problem, students are asked to use problem-solving skills to find how many eight-slice pizzas are needed for a class party during which each person eats two slices. The next section of the book addresses planning, implementation, and instructional issues related to problem-centered learning. Classroom examples show how number sense and computation skills can be learned within a problem-centered framework. Later sections of this book contain information about the development of children's mathematical thinking, teacher reflections on classroom experiences with problem-centered learning, and assessment suggestions. References include articles and reports on the theoretical foundation of problem-based learning, curriculum resources, and suggested children's literature. (Author/JRS) ENC-014532

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To Half or Half Not: Fractions, Decimals

Series: PBS MATHLINE Elementary School Math Project
Grades 2, 3
1997
Author: content director, L. Carey Bolster; producer, Bob Harris
Publisher: Thirteen/WNET

Part of the PBS MATHLINE series, this video on teaching fractions is one component of the Elementary School Math Project (ESMP). The ESMP features video lessons that model the teaching of mathematical concepts and demonstrate how these concepts can be developed over time in the classroom. This video features a lesson on equivalent fractions that uses fun, hands-on activities to help students understand this complex concept. Students use geoboards to discover ways to divide rectangles into halves. Another activity uses paper plates and a spinner for a game in which students try to cover one whole plate with cut-out fractions of that plate. All of the problems are couched as stories in which the students are active participants. The companion lesson guide gives a brief description of the activity, a lesson plan, extensions, connections with Internet sites, and blackline masters for student handouts. (Author/RMK) ENC-013111

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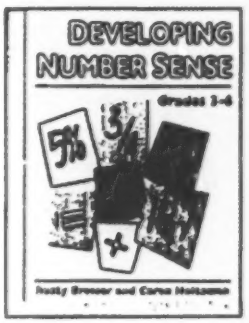
$69.98 per module (contains 8 titles)

Developing Number Sense, Grades 3-6

Grades 3-6
1999
Author: Rusty Bresser, Carne Holtzman
Publisher: Math Solutions Publications



The 13 activities in this book contain strategies for helping children build their number sense. The book provides practice in mental computation, basic facts, navigation of the number system, and estimation. Some of the activities are games that the teacher introduces and the students play in small groups; others are investigations that can be carried out by the students, either individually or in small groups. There are also some activities for whole-class work only. Each activity provides a concise summary and a vignette that describes how the activity was taught by the authors. Teachers will also find answers to one or more reflective questions. Examples of student work are given, as well as ideas for assessing student's understanding. For example, one activity is designed to help students connect ideas about fractions to real-world contexts. The students are given a recipe for trail mix that serves six people. The measurements include fractions that students often find challenging to work with, such as two thirds cup or three fourths cup. The students' task is to convert the recipe so that there is enough trail mix for everyone in the class. The first challenge is for the students to decide how many are actually in the class: Should absent students be considered, or should the teacher be included? One reflective question is: How can this activity be used to assess students' number sense? (Author/JAR) ENC-017389

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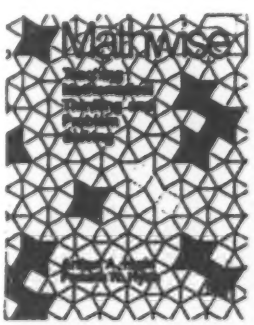
www.pearsonlearning.com
$22.95 per book (paperback)

Mathwise: Teaching Mathematical Thinking and Problem Solving

Grades 3-6
1991
Author: Arthur A. Hyde, Pamela B. Hyde



This book introduces teachers to a broad view of what it means for students to "do" mathematics. The authors explore the kinds of mathematical thinking that students are capable of doing and offer approaches, methods, and strategies for teaching that will foster this capability. The goal is to revitalize the curriculum in accordance with the NCTM *Curriculum and Evaluation Standards* (1989) by actively engaging students in working on authentic situations and real-life problems. Students are encouraged to formulate their own mathematical ideas and to share their conceptions with one another through discussion,

writing, and reading. The book features careful explanations of 10 important problem-solving strategies, such as acting out the problem and making tables and lists. The essence of each strategy is examined for the kind of thinking involved, the crucial steps that students must understand, and the pitfalls that are often ignored by textbooks. This problem-solving approach is designed to facilitate student understanding of mathematical concepts in the following areas: numbers, computation, and measurement; noncomputational concepts in mathematics; and mathematical relationships. (Author/LDR) ENC-005743

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Scholastic Educational Books, Inc., 50 Pine Road West, PO Box 5007, Westport, CT 06881
Email: customer@scholastic.com
(603) 431-7894 / Fax: (800) 393-1582 / Toll-free: (800) 793-2154
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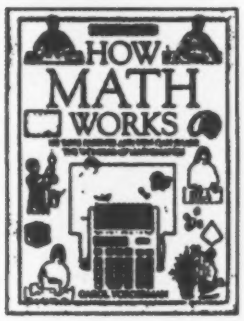
$22.50 per book

How Math Works

Grades 3-8
1996
Author: Carol Vorderman
Publisher: Reader's Digest Association, Inc.



Created to demonstrate the wonder and usefulness of mathematics, this book provides puzzles, problems, and hands-on experiments that develop mathematical concepts and demonstrate basic mathematical principles. Examples of these educational experiments include figuring out the volume of a hand, showing fractional differences while making music with a string, and finding the angle of elevation with a homemade astrolabe. The experiments illustrate mathematical connections to science. The full-color pictures in this book show students actively engaged in the hands-on experiments, illustrate the historical and architectural references, and highlight the commentary about the mathematics concepts. In a sample experiment for investigating proportions, students learn how to find the height of a tall building using the ratio of the height of a smaller object to the length of its shadow. Other ratio experiments involve creating a population density chart, mixing and matching primary colors to create tints, and making music from air and water with a collection of bottles. Answers to all problems and a glossary of terms are included. (Author/JRS) ENC-017001

Ordering Information
Reader's Digest Young Families Inc., Children's Trade Books, The Reader's Digest Association, Inc., Pleasantville, NY 10570
(212) 366-8899 / Fax: (800) 659-2436 / Toll-free: (800) 310-4261
www.readersdigest.com
$23.96 per activity book (paperback)

Teaching Fractions and Ratios for Understanding: Essential Content Knowledge and Strategies for Teachers

Grades 3-8
1999
Author: Susan J. Lamon

Teachers, researchers, and curriculum developers can all find something of value in this book, which focuses on developing a deeper understanding of proportional reasoning and rational numbers. The book concentrates on enhancing teacher's mathematics content knowledge and understanding, examining student thinking, and exploring teaching methods, instructional activities, and assessment. Author Susan Lamon believes that using the same questions and activities given to students enables teachers to build comfort and confidence in their ability to teach complex ideas. The problems and activities are designed to be useful in elementary and middle school classrooms and during family math nights. Each chapter includes self-assessment sections that invite the reader to stop and work examples before continuing; in addition, there are activities to try out the new ideas presented. Mathematics concepts are developed through detailed illustrations. Excerpts of student work give the reader an idea of what to expect from students. An extensive bibliography offers further reading about the development of proportional reasoning and other rational number concepts. (Author/JRS) ENC-018784

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www.erlbaum.com
$27.00 per book (paperback)
$16.50 per supplement (paperback)

Developing Mathematical Imagery: Activities for the Classroom

Series: *School Mathematics Project*
Grades: 6-11
1994
Author: contributing writers, Tony Burghall, Peter Critchley, Michael Darby, Tony Gardiner, Bob Hartman, Diana Sherrill

The 40 activities in this book are designed to develop mathematical imagery and strategies. Some of the activities involve visualization, some require the interpretation or construction of diagrams, and others develop strategies for mental arithmetic. Each one includes an introduction, a materials list, and suggestions for facilitating the activity. Math content ranges from arithmetic to patterns and algebra. A grid provides a summary of the activities, correlations to content strands, a brief description of each activity, and an estimate of time required. One activity, for example, encourages students to imagine what shapes will be made by different cuts across folded paper. Before making a cut, the students visualize and draw the shape they expect to get. Then they make the cut and compare. One question asked is: What happens if the second fold is not at right angles to the first? (Author /JAR) ENC-016961

Ordering Information
Cambridge University Press, 110 Midland Avenue, Port Chester, NY 10573
Email: orders@cup.org
Fax: (914) 937-4712 / Toll-free: (800) 872-7423
www.cup.org
$45.00 per book (paperback, spiral-bound) Includes 1 double-sided poster.

Exploring Symbols: An Introduction to Expressions and Functions

Series: Data-Driven Mathematics
Grades 7-12
1998
Author: Gail F. Burrill, Miriam Clifford, Richard Schaeffer

Part of the Data-Driven Mathematics series, this textbook and accompanying teacher's guide are designed to help beginning algebra students use real-world data to develop their thinking about symbols in expressions, equations, and functions. The text offers 12 lessons that address variables, expressions, formulas, and functions. A spreadsheet formulation of problems is often used so symbols acquire a natural meaning as column labels. Each lesson is designed around a problem or mathematical situation and begins with a series of introductory questions or scenarios that can prompt discussion and raise issues about that problem. The teacher's guide provides extensive notes on every page of the student book and contains answer keys, quizzes, an end-of-module test, and activity sheets. In the activity Creating Your Own Formulas, for example, the motivating questions include: What factors do you use to rate movies? How would you rate your family's car? Students then look at some real-life examples for which ranking systems have been used and answer questions such as: Why would anyone be interested in a ranking of cars that reflected the number of chronic defects in cars made by different manufacturers? Later in the activity students devise their own formulae for ranking high school football teams and cities. (Author/MM) ENC-018849

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www.pearsonlearning.com
$17.95 per book (paperback)
$25.95 per teacher edition with disk

Say It With Symbols: Algebraic Reasoning

Series: Connected Mathematics
Grade 8
1998
Author: Glenda Lappan, James T. Fey, William M. Fitzgerald, Susan N. Friel, Elizabeth Difanis Phillips
Publisher: Dale Seymour Publications

Part of the Connected Mathematics curriculum series, this student text and accompanying teacher's guide focus on the use of functions in modeling patterns of quantitative change. Students also learn to represent functions in graphs and tables. This unit is part of a series designed for grades 6-8 that develops students' mathematical knowledge and understanding through connections between mathematics and other school subjects and to the world outside the school. At each grade level, the curriculum consists of eight units organized around a series of investigations that emphasize a major concept or cluster of concepts. The series focuses on the strands of number, geometry and measurement, algebra, and statistics and probability. This unit features five investigations in which students explore symbols, the order of operations in evaluating expressions, symbolic sentences, and reasoning with equivalent sentences. In investigation four, for example, students review how to solve linear equations using a graph, a table, and algebraic methods. Students learn to solve equations of the form $ax + b = cx + d$ and are introduced to symbolic solutions of quadratic equations. The ultimate goal is for them to become aware of the strengths and weaknesses of each solution method. The teacher's guide describes mathematical goals for the unit and correlates Applications-Connections-Extensions (ACE) problems for homework assignments. The guide also includes a teaching timeline, suggested assessments, and blackline masters. (Author/LDR) ENC-010728

Ordering Information
Prentice Hall School Division, Box 11071, Des Moines, IA 50336
(800) 848-9500 / Fax (877) 260-2530 / Toll-free (800) 848-9500
www.phschool.com
$10.97 per teacher's guide
$5.95 per student text

Powers of Ten: A Film Dealing With the Relative Size of Things in the Universe and the Effect of Adding Another Zero

Series: Films of Charles and Ray Eames
Grades 9-12
1989
Author: Charles and Ray Eames

This program is part of a video collection that highlights the contributions of American designers Charles and Ray Eames to architecture, furniture design, industrial design, and the photographic arts. The first film on the video starts at a lakeside picnic in Chicago and transports the viewer to the outer edges of the universe. Every 10 seconds, the starting point is shown from another location 10 times farther out, until the viewer's own galaxy is visible only as a speck of light among many others. Returning to Earth, the camera moves inward, into the hand of the sleeping picnicker, with 10 times more magnification every 10 seconds. The journey ends inside a proton of a carbon atom within a DNA molecule in a white blood cell. The second film includes the original version of the first film and focuses on the relative size of things in the universe. This film also begins with the sleeping man at a picnic and takes the viewer through 36 powers of ten. Each vantage point is taken relative to a specific distance traveled in ten seconds, such as the distance a man can run, the distance a racing car can cover, and the distance a supersonic plane can travel. As the adventure continues to the outer edge of the universe, the focus remains on the rhythm of change between periods of activity. The magnification of powers every ten seconds is related to the orbital speed of light and the effect it has on our time scale. The journey ends back under the skin of the sleeping picnicker. (Author/VN) ENC-001799

Also available is a book version (ENC-018872) that includes commentary on the nature of the universe and measurement. (Bedford, Freeman & Worth Publishing Group, Toll-free: 888-330-8477, $22.95)

Ordering Information
Pyramid Media Orders, PO Box 1048, Santa Monica, CA 90406
(310) 828-7577 / Fax (310) 453-9083 / Toll-free (800) 421-2304
www.pyramidmedia.com
$79.95 per video (public performance version, VHS)

The Graph Club With Fizz & Martina

Grades: K-4
1998
Author: Peggy Healy Tenorio

Students can use this CD-ROM to cultivate the ability to read and interpret graphs and to use graphs to communicate information, answer questions, and solve problems. This program is intended to assist students in making the transition from graphing with manipulatives to graphing in the abstract. It addresses the relationship between different representations of the same data, for example, picture graph, bar graph, line graph, circle graph, and table. The program is correlated to the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989) and encourages cooperative learning, problem solving, and cross-curricular integration. Students can collect information, answer questions, make decisions, and solve problems. Sample graphs are included with the software for exploring and/or matching. The Explore mode generates a pair of graphs that let students explore graphing in an open-ended environment. The Match mode generates a random graph and challenges students to create a different type of graph to represent the same data. The Create mode permits students to enter collected data for graphing. The Guess mode encourages critical thinking and helps students understand that there can be many good answers to a question. Other options allow students to label and even write about their graphs in a text box. The teacher's guide includes blackline masters of sample graphs and activities as well as suggestions for how to introduce and assess graphing concepts and activities. (Author/LDR/GMM) ENC-014421

Ordering Information
Sum Snyder Productions, Inc., 80 Coolidge Hill Road, Watertown, MA 02472
Email: [illegible]
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www.tomsnyder.com
$79.95 per CD-ROM package
$359.95 per curriculum kit

Tracking Graphs

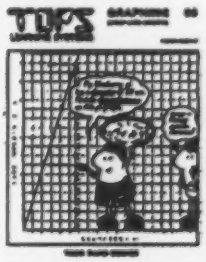
Series: *Mathematics in Context*
Grades: 6, 7
1998
Author: Wisconsin Center for Education Research and the Freudenthal Institute

Part of the Mathematics in Context series, this 13-day unit involves students in producing line graphs, reading data from graphs, and analyzing a graph's essential features. The series offers a complete middle school curriculum designed to place mathematical content into a variety of real-world contexts. The curriculum's content is divided into the strands of number, algebra, geometry, and statistics. For each unit, a teacher's guide includes lesson overviews, teaching strategies, student materials, and blackline masters for a letter to families, student activity sheets, and assessments. In one lesson, Graphing of Tides, students investigate data about tides and use the information to make decisions on whether ships can enter a harbor or not. They also produce and examine a vertical translation or shift of a graph. Teacher materials for this unit, part of the algebra strand, include suggestions for informal and formal assessment, extensions, and journal writing. This series reflects the 1989 NCTM standards. (Author/JRS) ENC-012882

Ordering Information
Encyclopedia Britannica, Inc., Mathematics in Context, 310 South Michigan Avenue, Chicago, IL 60604
Fax: (312) 347-7966 / Toll-free: (800) 554-9862x7087
www.britannica.com
$5.35 per student text
$21.55 per teacher's guide

Graphing

Series: *Task Cards*
Grades: 7-12
1990
Author: Ron Marson



This book contains 20 reproducible student activity cards that teach how to measure variables, generate data, and plot graphs. The Task Cards series is based on a model that views science as an individualized process of creative inquiry and a traditional body of knowledge. Students work alone or in cooperative groups to complete activities at their own pace. Each student is responsible for a brief, individual write-up explaining the activity. With this set, students explore how the slope of a straight line or the direction of a curve corresponds to the stretch of a rubber band or the curve in a flask. In a sample activity, students map normal rectangular images onto circular graph paper to create a distorted image. Students then reflect the circular projection with a piece of shiny chrome tubing and find the normal image restored. Included are answers to all questions on the cards along with suggestions for assessment and use of other sets of activity cards in the series. A related web site offers free samples of TOPS lessons. (Author/JRS) ENC-016120

Ordering Information
TOPS Learning Systems, 10970 S. Mulino Road, Canby, OR 97013
(503) 266-0550 / Fax: (503) 266-5200
www.topslearn.org
$9.50 per activity book (paperback)

Organizing and Analyzing Data: Statistics

Teach-Stat Activities: Statistical Investigations for Grades 3-6

Series: Teach-Stat
Grades: 3-6
1997
Author: project editor, Jean Gibson

The materials in this teacher resource book, part of the Teach-Stat series, are designed for conducting statistical investigations on topics that include discovering preferences in bubble gum and finding how many drops of water will fit on a penny. The series offers student activities for grades 1-6 and professional development resources. The activity books apply a four-stage model for statistical investigation that is intended to give structure and direction to the reasoning used

in statistical problem solving. In this model, students identify and pose a specific question, collect the data, organize and display the data, and use the results from analyses to make decisions about the original question. In a sample activity, students gather and represent data about inherited traits, such as the ability to roll the tongue. In the first activity, students gather data on 100 subjects to create a model of percent that is easy to interpret. Students graph the data to answer the question: What percentage of students can roll their tongue? In the second activity, they gather data to answer the question: Are the parents and siblings of tongue rollers also tongue rollers? (Author/JRS) ENC-016409

Also available in this series is Teach-Stat Activities: Statistical Investigations for Grades 1 Through 3 *(ENC-013831).* Teach-Stat for Statistics Educators: Staff Developers Manual *(ENC-018251) is a guide for a one-week staff development institute that prepares teachers to plan and implement their own Teach-Stat workshops.* Teach-Stat for Teachers *(ENC-018683) provides a guide for a three-week workshop for leaders who have taken the one-week staff development course.*

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$16.95 per activity book (paperback)

Exploring Statistics in the Elementary Grades, Book 2: Grades 4-8

Series: Elementary Quantitative Literacy (EQL) Project
Grades 4-8
1999
Author: Carolyn Boroska, Cynthia N. Bolster, L. Carey Bolster, Richard Scheaffer

These 22 statistics investigations apply graphical techniques such as two-way frequency table, box plot, and time plot series. They constitute the second book in the Elementary Quantitative Literacy Project, a collaboration of statisticians and classroom teachers offering field-tested ways to present the vocabulary and symbolism of statistics and probability. The investigations are written to enhance the content background of the teacher and to provide actual lessons to be adapted for students. Each investigation includes reproducible student pages and detailed teaching instructions. Background statistical information and a glossary of terms are also provided. In a sample investigation, Predictable Pairs, students gather data related to two questions chosen from a previously given survey and organize two-way frequency tables. Students construct arguments for or against the association of the two survey questions by calculating marginal proportions, conditional proportions, and joint relative frequencies. (Author/JRS) ENC-017947

Also available from this series is Exploring Statistics in the Elementary Grades, Book 1: Grades K-6 *(ENC-017946).*

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Data: Kids, Cats, and Ads

Series: Investigations in Number, Data, and Space
Grade 5
1996
Author: Andee Rubin, Jan Mokros, Rebecca Corwin, Susan Friel
Publisher: Dale Seymour Publications

This teacher's resource book focuses on describing, representing, and comparing data sets. It is part of the Investigations in Number, Data, and Space series, a complete K-5 mathematics curriculum that emphasizes depth in mathematical thinking rather than superficial exposure to a series of fragmented topics. The Investigations curriculum is presented through a series of teacher books, one for each unit of study. Reproducible student resources are provided, but student books are not included. Students work actively with objects and experiences in their own environment and with a variety of manipulative materials and technology, rather than with workbooks and worksheets. Each of the five investigations in this book includes three to five sessions (with a session being defined as a one hour math class). Activities include pair and small group work, individual tasks, and whole class discussions. A sample investigation, Balancing Act, emphasizes line plots, medians, and hypotheses as they relate to data sets. In Session 1, students collect data about how long they can stand on one foot with their eyes closed. In Sessions 2 and 3, students examine data sets collected from adults balancing on one foot and compare these data with their own. In Session 4, small groups of students consider and analyze different sets of data on balancing that have been collected from gymnasts, karate students, younger children, and people over 50. Recommendations for homework assignments and follow-up activities are included for each activity. Embedded assessment activities are recommended throughout each investigation. Portfolio and observational assessments are also recommended on an ongoing basis. (Author/CMS/KFR) ENC-010723

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www.scottforesman.com
$26.51 per book
$321.40 per teacher resource package
Contact publisher for additional ordering options.

Data Analysis and Statistics Across the Curriculum

Series: Addenda
Grades 9-12
1992
Author: Gail Burrill, John C. Burrill, Pamela Coffield, Gretchen Davis, Jan de Lange, Diane Resnick, Murray Siegel

Written by classroom teachers, mathematics supervisors, and university mathematics educators, this volume provides examples and activities that illustrate how data analysis and statistical thinking can be integrated into the standard high school mathematics curriculum. The book also addresses how data analysis and statisitcs can be integrated with the algebra, functions, and geometry strands of the 1989 NCTM standards. The authors make connections between statistics, real-world contexts, and

other school subjects. The volume is part of the Addenda Series, which was designed to provide instructional ideas and materials to support implementation of the 1989 standards in local settings. In this book, problem situations and tasks involve students in designing experiments, collecting and organizing data, and representing the data with visual displays and summary statistics. Students also analyze the data, communicate the results, and (where appropriate) search for prediction models. More extensive investigations and problems are found in classroom-ready blackline masters at the end of each chapter. Solutions and comments are provided. Margin notes supply instructional suggestions, identify possible student misconceptions, and provide assessment suggestions. Ideas and resources for student projects along with methods for evaluating student projects are provided, including samples of actual student work. Additional sources of ideas and materials are identified in a selective annotated bibliography at the end of the volume. (AM) ENC-000666

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National Council of Teachers of Mathematics, Inc., 1906 Association Drive, Reston, VA 20191
Email: orders@nctm.org
(703) 620-9840 / Fax: (703) 476-2970 / Toll-free: (800) 235-7566
www.nctm.org
$17.95 per book

Exploring Data

exploringdata.cqu.edu.au
Grades 10-12
1997
Author: Ian Beggs
Publisher: Queensland Department of Education

The material at this web site, developed by an Australian mathematics teacher, contains activities, worksheets, and overhead transparency masters for introductory statistics. Also included are data sets complete with stories about their origins, and assessment to support data exploration. The site emphasizes the importance of extending teachers' knowledge of statistics and the central place of real data in students' understanding of the subject. To help visitors explore such concepts as stemplots, normal distribution, and probability, the site offers teacher notes on the meaning and relevance of the concept, plus extension articles directly available as downloadable documents or as links to web pages. Furthermore, activities are outlined and accompanied by sets of real data. A resource page contains a list of resources available to support introductory statistics. Links to tutorials and other mathematical web sites are included. Winner, ENC Digital Dozen, August 1999. (Author/JRS) ENC-011678

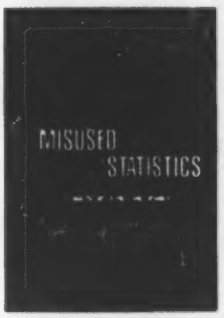
Internet Projects for Elementary Statistics

hepg.awl.com/weiss/e_iprojects/index.htm
Grade 10 and up
2000
Author: Tim Arnold; based on Elementary statistics (4th edition), by Neil Weiss
Publisher: Addison Wesley Longman

Although this site is designed to complement an Addison Wesley elementary statistics textbook, it contains activities that are useful to anyone interested in statistics and in using elementary statistics techniques to explore real-world data. Divided into 14 chapters, the site provides projects based on various Internet data sources, along with interactive graphical tools and simulations for analyzing the data. A sample project, Global Warming, begins with online references to help the user learn about the mechanisms behind the phenomenon of global warming. Resource materials include a historical timeline that traces the global warming phenomenon; graphs of temperature over the last 100 years; and information links to opposing views held by scientists about global warming. The project uses the statistical concept of confidence intervals to analyze the temperature data collected by the Intergovernmental Panel on Climate Change. Winner, ENC Digital Dozen, January 2000. (Author/JRS) ENC-016350

Misused Statistics

Series: Popular Statistics
Grade 10 and up
1998
Author: Herbert R. Spirer, Louise Spirer, A.J. Jaffe



This book, in its second edition, supplements statistics textbooks and addresses some of the problems inherent in statistical practice. It begins with an introduction to statistical methods and goes on to classify types of misused statistics, using documented, real-world examples drawn from sources such as the media, public policy, polls, and advertising. The book is intended mainly for people whose statistical knowledge is less than that of a professional statistician. Among the sources of error discussed in the book are graphics and presentation, faulty interpretation, and faulty assumptions. In the chapter on thinking, for instance, there is an example of the so-called Janus effect, whereby an inference is made in one direction only: The admissions committee of a university wants to increase the number of admissions granted to students from small towns and rural areas. It is considering the application of a rural student for the school's engineering program. The student has very high test scores, particularly in mathematics, but has misspelled the word engineering on her application. A member of the committee suggests dyslexia as the problem, and the student is put on the wait list. The committee member failed to "look both ways" in the sense that, although he concluded there is a high probability that a dyslectic would misspell a word, he failed to consider the probability of a nondyslectic misspelling words. The book includes an extensive list of references. (Author/MM) ENC-018855

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(914) 796-1919 / Fax: (914) 796-1772
Toll-free: (800) 228-1160
www.dekker.com
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Probability, Grades 1 to 2 [Kit]

Series: Math by All Means
Grades 1, 2
1996
Author: Cuisenaire Company of America, Inc.

This kit of manipulative materials, part of the Math by All Means series, is designed to accompany a five- to six-week unit on probability. The series has been designed to correlate with the 1989 NCTM standards. Each unit uses whole-class lessons, menu activities, assessments, and homework to integrate the primary topic with other strands (in this case, the strands of number, computation, geometry, and statistics). The unit on probability provides a broad range of problem-solving experiences. Games, activities, and investigations are accessible by those with limited math experience and also have the potential to stimulate and challenge more capable and experienced learners. This accompanying kit contains a classroom set of manipulatives suggested by the lessons, menu activities for student use, and overhead transparencies. In addition to manipulatives such as dice, color tiles, and snap cubes, the kit contains guides describing activities that have been successfully used to present and develop mathematical concepts at various grade levels. Menu activities, which allow children to work in groups, pairs, or individually, are designed to pose problems, create situatjons, and ask questions that help children to interact with the unit topic. (Author/GMM/CMS) ENC-009425

Also available is Probability, Grades 3 to 4 *[Kit] (ENC-008030), which integrates probability with topics such as number, geometry, statistics, and measurement.*

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ETACuisenaire, 500 Greenview Court, Vernon Hills, IL 60061
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www.etacuisenaire.com
$168.95 per kit

Chances Are... Part 1: Probability

Series: PBS MATHLINE, Elementary School Math Project
Grade 3
1996
Author: producer, Elizabeth A. Hardeow; writer, Diane Harrison
Publisher: Thirteen/WNET

Part of the PBS MATHLINE series and one component of the Elementary School Math Project (ESMP), this video program shows the implementation of a lesson on probability. The ESMP comprises video lessons that model the teaching of mathematical concepts, demonstrate how these concepts can be developed over time in the classroom, and provide a forum for discussing issues related to teaching in elementary schools. In this lesson, the focus is on the probability scale (0 as an impossibility, 1 as certainty). Students rate the probabilities of different events by walking up and down the probability scale and learn, as a result of this hands-on approach, how to interpret the probability spectrum. The companion lesson guide gives a brief description of the activity, a lesson plan, extensions, releated Internet links, and blackline masters for student handouts. (Author/RMK) ENC-013099

Also on this same videotape are two other lessons. Part 2 (ENC-013100) focuses on outcomes and the probability assigned to a given outcome, while Part 3 (ENC-013101) focuses on simulating the likelihood of an event and making predictions.

Ordering Information
Public Broadcasting Service, 1320 Braddock Place, Alexandria, VA 22314
Email: shopdistribution@pbs.org
(703) 739-5021 / Fax: (703) 739-7513 / Toll-free: (800) 645-4727
www.pbs.org
$60.00 per module (contains 8 titles)

Probability

Series: Math Concepts in Motion
Grades 4-6
1999
Author: GAMCO Industries, Inc.

This CD-ROM contains tutorials, activities, and tests that engage students in using probability concepts to make informed decisions, search for patterns in events, and make predictions. Students can also use the CD to conduct experiments in probability, solve problems, predict outcomes, and explore randomness. The program is part of the Math Concepts in Motion series, which uses graphics and animation to teach and practice math topics that include graphing and data management, measurement, and patterning. On this disc are seven tutorial lessons that introduce the meaning of probability and the ways it is expressed in the mathematical world. In one interactive tutorial, for example, students explore the difference between theoretical and experimental probabilities. In the tutorial, coins are tossed, onscreen results are tallied, and a tree diagram showing all the possible outcomes is created. Included with the CD are a user guide and a teacher guide with information on program content and reproducible materials. (Author/JRS) ENC-017366

Ordering Information
GAMCO Educational Materials, 3225 N. Kirkwood Road, Suite 200, St. Louis, MO 63122
Fax: (800) 896-1760 / Toll-free: (800) 726-8100
$69.95 per CD-ROM package (Mac/Windows)

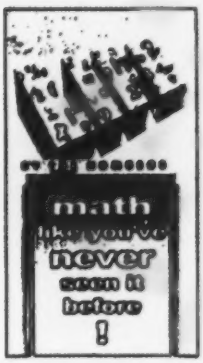
Chance and Data in the News

www.ni.com.au/mercury/mathguys/mercury.htm
Grades 7-12
1997
Author: presented by The Mercury, the University of Tasmania, and the Australian Association of Mathematics Teachers (AAMT), Inc.

At this web site, users can access newspaper articles from *The Mercury*, the Tasmanian metropolitan daily newspaper, for mathematical investigations dealing with probability, statistics, and numeracy. Each of the site's six sections contains introductory questions, applicable to all the articles in the section, that deal with the application of statistics and probability. In each subsection there is a wide range of articles to illustrate the use and interpretation of statistical data. Also found with each article is a short discussion to help the user understand the application of statistics in the article. For example, in the Data Collection and Sampling subsection, the articles explore the legalization of drug use, hand gun laws, school policies on gay students, and the effect of fluoride on teeth. The introductory questions deal with the relationship between populations and samples, the conclusions that can be drawn from the data, and the possible impact of funding sources on the significance of the reported results. The articles are also cross-referenced by topic for use in projects or by teachers of subject areas other than mathematics. (Author/JRS) ENC-014910

Chances of a Lifetime: Probability

Series: Life by the Numbers
Grades 7-12
1998
Author: producer and writer, Joe Seamans



This video illustrates how mathematics can make sense of life by applying probability to gauge chance and risk and by using statistical methods to make predictions about everything from weather to the roulette wheel. It is part of the Life by the Numbers series, which highlights the crucial role mathematics plays in real life by exploring topics such as sports, technology, and space exploration. This video focuses on how patterns found in random events can be used to predict the future in baseball games and in the gambling casino. Highlights include a look at voting trends as measured by a pollster/statistician who explains sampling with representative groups. The impact of statistics on medical research is illustrated with footage from the 1954 clinical trials of the polio vaccine. The teaching guide features four-page spreads for each video that include classroom activities, thematic overviews, and mathematical background information on key concepts. The guide includes a description of a school math trail with activities geared to locations likely to be found in most schools. Students work with proportion and scale, the tangent function, slope, and patterns and fractals while answering questions related to their school. All activities in the guide can be used independently or to support classroom use of the videos. (Author/JRS) ENC-014172

Ordering Information
WQED Orders, 4802 Fifth Avenue, Pittsburgh, PA 15213
(412) 622-1304 / Toll-free: (800) 274-1307
$19.95 per video
Free off air taping rights for 6 years on all shows.
$120.00 per series (7 videos) Add $9 for shipping and handling

Applying Mathematics

A Money Adventure: Earning, Saving, Spending, Sharing

Series: One and Only Common Sense [Cents]
Grades K-3
1996
Author: Neale S. Godfrey

The 22 activities in this kit deal with the concepts of operating a small business, risk, profit and loss, and money transactions. It is part of a series designed to help primary grade students develop financial literacy. Through the adventures of the Green$treet$ Kids, children learn about money and explore principles of economics while they learn mathematics. The units are designed to introduce or replace a unit on money or can serve as a source of supplemental activities. A story involving the Green$treet$ Kids introduces each unit. Other materials in the kit include a read-along cassette, a teacher's guide, a money tray, and a game. In addition to activities, the teacher's guide provides an idea bank of related projects, reproducible activity masters, and home transaction letters. Informal assessment is encouraged in the series through the use of Passbooks, personalized financial-themed notebooks in which children can write or draw their responses to an activity and collect important papers. Assessment masters are also provided. Sample activities from this unit are More Ways Than One, in which children use problem-solving strategies to find coin combinations that make one dollar; and the Fair Share Game, in which children play a game that involves dividing profits fairly among business partners. The Judy/Instructo Make a Dollar card game included in this unit is designed to reinforce coin recognition and coin equivalences. (Author/GMM) ENC-008004

Ordering Information
Pearson Curriculum Press, Pearson Education, PO Box 2649, Columbus, OH 43216
Fax: (800) 393-3156 / Toll-free: (800) 526-9907
[illegible]
$295.50 per classroom kit (Includes: 1 big book; 1 teacher's guide; 24 student books; 1 cassette; 1 money tray with classroom money; 1 Make a Dollar card game; 1 nylon storage bag)
Contact publisher for additional ordering options.

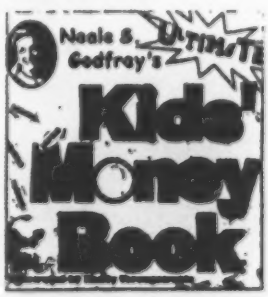
Investing for Kids

tqd.advanced.org/3096/
Grade 1 and up
1997
Author: David Leung, Steven Ngai, Hassan Mirza
Publisher: Advanced Network and Services, Inc.

Three California high school students designed this children's web site to offer a wealth of information about investing in the stock market. The site answers basic questions such as: How does money grow? and When and Why should I invest? It explains the seven basic types of investments. Software is available at the site for setting up stock portfolios. Links are provided to current market readings and information about specific stocks. The Java Financial Goal Calculator section, for example, contains a user-friendly format that allows the investor to enter five different financial goals with different initial investments amounts, monthly investments, and rates of return. The program calculates and displays the time needed to reach the goals and investment gains in dollars for each of the five investment strategies. The use of the Goal Calculator is illustrated with five sample college funding plans to generate $50,000. Other sections of the site include an introductory financial quiz, a glossary of stock terms, and a stock market simulator. Winner, ENC Digital Dozen, April 1998. (Author/JRS) ENC-012044

Neale S. Godfrey's Ultimate Kids' Money Book

Grades 3-8
1998
Author: Neale S. Godfrey



This illustrated guidebook is written to introduce children to all aspects of money from ancient to modern times. Its nine chapters deal with the origins of monetary systems, the ways that banks operate, the ins and outs of credit cards, and the modern stock markets. Also covered is the mechanism of how the econo-

my works and the relationship between government and money. The book is very visual; for example, it uses a set of cartoons to illustrate the journey of a check through the financial system. Between chapters, there is a page of puzzles, with answers given at the back of the book. Student readers gain an extensive financial vocabulary. On every page of the book, there are questions for readers to consider, such as the following scenario: Government laws limit the interest that banks may charge for loans. What do think would happen if there were no such laws? Do you think all banks charge the same rates? Are laws good for the customer? A complete glossary of the financial terms used is included as an appendix. (Author/MM) ENC-018843

Ordering Information
Simon & Schuster Publishing Children, 100 Front Street, Riverside, NJ 08075
Fax: (800) 943-9831 / Toll-free: (800) 223-2336
www.simonsayskids.com
$19.00 per book (hardbound)

A Blueprint for Geometry

Series: Math Projects
Grades: 5-8
1998
Author: Brad S. Fulton, Bill Lombard

In this curriculum unit are two to three weeks of activities that engage students in the study of geometry as they solve problems based on a real-world situation. Students learn how to read and draw floor plans and elevations, take measurements and reduce them to a scale, and compute building costs. The unit is intended to help students transition from concrete to more abstract mathematics concepts. In a sample activity, students act as building inspectors and review floor plans for accuracy and practicality based on a given set of building code rules. They compute the square footage of a house plan and calculate the cost per square foot. For this and other activities, students use actual drafting tools or tools fashioned from blackline masters provided in the book. Activities are based on and aligned with the goals defined in the 1989 NCTM standards. The teacher notes for each activity contain a materials list, classroom procedures with answers to problems, and extension and homework activities. A glossary of construction terms and a list of architectural symbols are included. (Author/JRS) ENC-018850

Ordering Information
Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 321-3106
www.pearsonlearning.com
$19.95 per activity book with 11 blueprint plans (loose sheets)
Contact vendor for pricing on companion poster or the book and poster set.

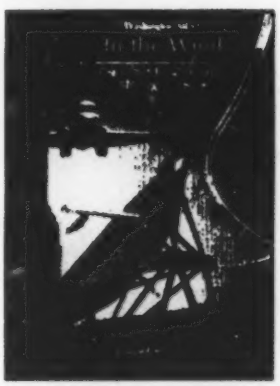
Mathematics of Cartography

math.rice.edu/~lanius/pres/map/
Grades: 5-12
1996
Author: Cynthia Lanius
Publisher: Rice University

Students and teachers can use this web site to learn about mapmaking and maps. From the home page, users may access information on the history of mapmaking, which highlights the progression from stick charts and footprints to clay tablets to the use of photographs and computers. The site includes teaching notes, lesson details, and references to online and offline resources. Maps are defined and described in terms of points, lines, area patterns, and colors. Mathematics topics used in mapmaking are discussed, including scale, coordinate systems, and projection. Links are provided to sites that give examples of the concepts described. The site discusses the distortions created by projecting three-dimensional space onto a two-dimensional piece of paper, explaining that different projections are designed to minimize the distortion of particular properties. For example, the Mercator Projection Angles preserve angles, but distances become progressively more distorted with distance from the equator. A link providing examples of other projections is available. One of four problem-solving questions asks the user to determine the point on the Earth that has the maximum distance (as the crow flies) from the user's home. More than 40 links to other Internet sites are available, providing insights into multiple aspects and applications of mapping, as well as current job listings in cartography and related careers. Winner, ENC Digital Dozen, February 1997. (Author/LDR) ENC-002328

In the Wind

Series: MESA
Grades: 6-8
1997
Author: Christine V. Johnson



This book explores the mathematics and methods pilots use to navigate in windy conditions. The cross-curriculum series combines essential prealgebra topics with hands-on science explorations to motivate students in both areas of study. Using materials and group collaboration to solve open-ended problems, students are encouraged to make connections between classroom and real-world applications through links to writing, history, technology and careers. In this module, the focus is on vectors. Each activity begins with an overview page, followed by background information for the teacher's use and suggested discussion questions and assessment strategies. Also included are project ideas for students to complete with their families. In a sample activity, Drifting Apart, students consider how wind conditions affect the direction of an airplane in flight. Using scale drawings on grid paper, they extend course lines to examine the relationship between the distance traveled on an incorrect heading and the number of miles a pilot is off course. The concepts of drift angle and ground track are introduced. The material explores the career of an aeronautical engineer and provides a historical study of female aviator Amelia Earhart. In a family activity on wind tunnels, students work with family members to build a simple wind tunnel using such materials as cardboard boxes, an electric fan, and a small utility hook. Each module also includes materials lists, blackline activity masters, and transparency masters. Completed student worksheets, with answers, are provided at the end of the book. (Author/YK) ENC-014235

Ordering Information
Dale Seymour Publications, 4350 Equity Drive, PO Box 2649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 321-3106
www.pearsonlearning.com
$21.95 per book (paperback)

Stock Market Simulations

Series: Simulations
Grades 6-9
2000
Author: Stephanie Bearden, Tracy Kabat

This book provides an interactive way to interest students in the world of business and finance, particularly the stock market. The first section introduces the vocabulary and history of the stock market. In the second section are stock market simulation activities in which students invest imaginary dollars in real companies identified through the newspapers or the Internet. Then, students work in pairs to create simulated companies meant to attract the investment of fellow students. They have to develop a company name and logo, draft a mission statement, and establish company goals. In the succeeding activities, students issue stocks and trade with other student-created companies. During the course of these activities, students learn to create bar graphs, circle graphs, and line graphs. The book's third section consists of a stock market crash simulation. Blackline masters are provided for all activities as well as a brief guide to relevant Internet resources. (Author/MM) ENC-018853

Ordering Information
Teacher Created Materials, Inc., 6421 Industry Way, Westminster, CA 92683
Fax: (800) 525-1254 / Toll-free: (800) 662-4321
www.teachercreated.com
$7.95 per activity book (paperback)

Geometry Activities From Many Cultures

Grades 6-10
1997
Author: Beatrice Lumpkin

The 65 reproducible worksheets in this book form a structured approach for teaching geometry in a multicultural context. Topics addressed include art, measurement, mapmaking, architecture, and trigonometry; each one is placed in a cultural context, such as Ancient Greek, Native American, Modern African, or Aztec. To facilitate classroom integration of the activities, the book is structured in the standard geometry textbook sequence. Units for each topic open with one or two pages of reading about the geometric achievement of the culture, followed by questions for critical thinking. Each unit concludes with teacher notes, answers, activities, and projects. In the activity on non-Euclidean geometry, for example, students are introduced to the idea of different geometries by a discussion on parallel lines in different spaces. Students then investigate a geometry with no parallel lines by pasting a right-angled triangle onto a sphere and taking measurements with a flexible protractor. Specific questions included with the activity address the sum of the angles of plane and spherical triangles. (Author/MM) ENC-018170

Ordering Information
J. Weston Walch, Publisher, 321 Valley Street, PO Box 658, Portland, ME 04104
Email: customer_service@mail.walch.com
(207) 772-2846 / Fax: (207) 772-3105 / Toll-free: (800) 341-6094
www.walch.com
$19.95 per activity book (paperback)

Math in Daily Life: How Do Numbers Affect Everyday Decisions?

www.learner.org/exhibits/dailymath/
Series: Annenberg/CPB Project Exhibits Collection
Grades 6-12
1998
Author: academic specialists, Janice Hadfield, Betsy Tarpik; project manager, Jennifer Fleming

Part of the Annenberg/CPB Project Exhibits Collection, this web site explores how math principles can be helpful when deciding whether to buy or lease a car, following a recipe, or decorating a home. The site is organized into six themes that describe mathematical concepts and offer hands-on application activities. As an example, the section Playing to Win explains how to find mathematical probability and describes how these rules define long-term outcomes for gambling casinos. In another section, Population Growth, there is a hands-on activity for calculating simple and compound interest on retirement savings, along with information about different ways to communicate data visually. A bibliography and links to other mathematical web sites also provided. Winner, ENC Digital Dozen, March 1999. (Author/JRS) ENC-014301

Six Billion and Beyond: Population in the New Millennium

www.pbs.org/sixbillion/
Series: PBS Online
Grade 6 and up
1999
Author: creative direction/design, Amy Walsh; content development, Megan Gelstein
Publisher: PBS Online

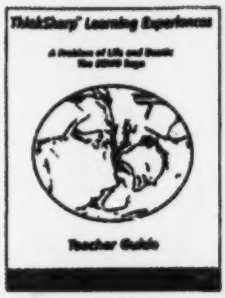
This web site explores population issues as they affect peoples' lives and countries. A clickable world map serves as the entry to population information about six countries: China, India, Italy, Kenya, Mexico, and the United States. A counter at the site keeps track of world population and notes how many babies are born during the time a visitor remains at the site. An overview for each country explains its situation regarding population growth or decline and examines the environmental and economic impact of population. Each country's situation is personalized through perspectives on population from four citizens. These personal perspectives explore issues that include the impact of the one-child policy on families in China and the effect that young women's career aspirations are having on Italy's declining population. Also found on the site are a study guide with discussion questions and fact sheets for each country, a list of web resources related to population, and an overview of international policy on population growth. Winner, ENC Digital Dozen, January 2000. (Author/JRS) ENC-016490

A Problem of Life and Death: The ECMO Saga

Series: ThinkSharp Learning Experiences
Grades 7-12
1999
Author: ThinkSharp, Inc.

Part of the ThinkSharp series, this kit contains multimedia materials for a program in which students apply data analysis techniques to determine which newborns are good candidates for treatment with a risky, yet potentially lifesaving, heart/lung bypass therapy. The series offers supplementary mathematics programs with video presentations that create a

real-world context for open-ended problem-solving activities. In the video for Part One of this program, students see a helicopter delivering a newborn baby in respiratory distress to a hospital and learn about the baby's situation. Students learn what Extracorporeal Membrane Oxygenation (ECMO) therapy is and when it is typically used. Working in groups, students are given a diagram of the ECMO heart-lung pump, data from the early 1980s about babies with severe respiratory illness, and definitions related to the data. Seven data elements are given for each baby. Students are challenged to determine which of these elements can be used to separate survivals from deaths. The goal is to specify, on the basis of the data, a subset of the 30 babies that have a less than 20 percent chance of survival; these babies are considered reasonable candidates for the ECMO therapy. In Part Two, students view the next segment of the video describing the benefits and risks of incubator and ECMO therapies. Stem-and-leaf diagrams and box plots are introduced as techniques for helping to determine which data elements most closely correlate to infant deaths. In the final two parts, students use scattergrams to make medical decisions and learn about the international controversy surrounding medical testing procedures. Also included with this program is a CD-ROM featuring an interactive interview with a doctor who answers frequently asked questions about ECMO therapy. The CD also documents one child's experience and successful therapy outcome. Activities are correlated to the 1989 NCTM standards. (Author/JRS) ENC-016737



Ordering Information
ThinkSharp, Inc., 539 Rock Spring Road, Bel Air, MD 21014
Email: contact@thinksharp.com
(410) 893-5330 / Fax: (410) 893-5820 / Toll-free: (800) 944-6520
www.thinksharp.com
$699.00 per kit (includes teacher's guide, videotape, and CD-ROM)
Includes 5% shipping and handling

Mathematical Modeling: Using Graphs and Matrices

Series: Learning in Motion
Grades 9-12
1997
Author: Learning in Motion

Using the interactive activities in this software package, students work with matrices and graphs to model situations such as airline or car routes, cooperation and competition, and population growth and decline. The software allows students to manipulate data and explore the connection between the visual representation (graph) and numerical representations (table and matrix). The accompanying teacher guide features background information on discrete mathematics topics such as similarity of graphs, map coloring, and Markov processes. There are also step-by-step illustrated directions for using the software's drawing and calculating features. In the second section of the guide, reproducible student worksheets with teacher notes state the goals and answers for each worksheet activity. In a sample activity, students use the software to simulate traffic flow on a given network of streets during the evening rush hour. Data are shown on the network or graph and in a matrix to indicate the number of cars passing through each intersection in 15-minute intervals. Students develop strategies and modify the traffic flow so that each intersection is not overloaded with cars. As they investigate their modification, students answer a series of questions, compute the traffic distribution using the software to do matrix multiplications, and then write an explanation to justify their decision. (Author/JRS) ENC-018932

Ordering Information
Learning in Motion, 580 Seabright Avenue, Suite 105, Santa Cruz, CA 95062
Email: help@learn.motion.com
(831) 457-5600 / Fax: (831) 457-0674 / Toll-free: (800) 560-5670
www.learn.motion.com
$59.00 per software package (Windows)

Mathematics for Decision Making in Industry and Government: High School Modules

mie.eng.wayne.edu/faculty/chelst/informs
Grades 9-12
1997
Author: webmaster, Azriel Chelst
Publisher: Wayne State University

This web site contains classroom-ready, real-world applications of linear programming. The goal of the site is to motivate students to learn mathematics by demonstrating ways in which the mathematics they are learning is actually used in industry and government. Two modules provide practice using systems of linear inequalities in linear programming for problems involving worker scheduling and product mix. The modules are designed as self-contained supplements to the high school curriculum. One module, High Step Shoes, includes a four-page packet for classroom use, teacher instructions and sample overheads, homework problems, case studies, and suggestions for student projects. In this module, the goal is to maximize the profit of a factory that produces two types of shoes. Constraints include number of machines, hours machines can work per week, and manpower hours available. In the student pages of this module, the student is guided through the development of the solution, and the final graph is given. In addition to the teaching modules, this site contains brief histories of operations research and linear programming, as well as short case studies showing the use of linear programming to solve problems in industries around the world. Case studies include the Nabisco Company, production for farmers in China, and the lumber industry in Mexico. Winner, ENC Digital Dozen, March 1998. (Author/JRS) ENC-011878

Real-World Math With the CBL System: Activities for the TI-83 and TI-83 Plus

Grades 9-12
1999
Author: Chris Brueningen, Bill Bower, Linda Antinone, Elsa Brueningen-Kerner

The 31 activities in this teacher resource book are designed to provide math students with a way to explore real-world applications of mathematical concepts. The activities were developed by teachers who are active in professional development programs for secondary math and science teachers. All activities incorporate the Texas Instruments (TI) Calculator Based Laboratory (CBL) System (not included), which is used to collect various kinds of data. The data are loaded

directly into a TI graphing calculator (not included) so that students can generate graphs and analyze the results. Probes and sensors used in data collection include TI's light, temperature, and voltage probes, as well as Vernier's motion detector, student force sensor, microphone, pressure sensor, and pH meter system (not included). Functions studied include linear, quadratic, exponential, sinusoidal, and piecewise-defined. Each activity is presented in worksheet format with background information, setup diagrams, general instructions, and space provided for students to record data and complete exercises. The activities feature CBL programs with onscreen menus and procedures to aid students, especially those with limited knowledge of graphing calculators or the CBL. Diskettes are included from which activity programs and sample data may be downloaded using the TI GRAPH LINK software and cable package (not included). Students can use one of the programs to enable them to link calculators and transfer collected or sample data for individual analysis. Extensions and further applications are included in most activities. Teacher information sheets supply suggestions for completing the activities, as well as sample data plots and answers to student questions. (Author/MPN/JRS) ENC-014537

Ordering Information
Texas Instruments, Inc., Attn: Accessories, PO Box 650311 MS 3962, Dallas, TX 75265
Email: ti-cares@ti.com
(972) 917-8325 / Fax: (972) 917-8347 / Toll-free: (800) 842-2737
www.ti.com/calc
$22.50 per activity book including computer disks
Suggested retail price. Call 1-800-TI CARES for vendor referral and pricing (TI indicates that dealers set prices).

Mathematics in Biology

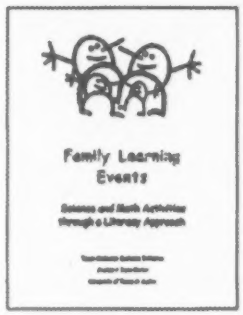
www.bio.brandeis.edu/biomath/top.html
Grade 11 and up
1997
Author: Geoffrey Dixon, Steven Kurd, Frank Lonberg, Mike Casey
Publisher: Brandeis University

This web site offers concrete interactive simulations of scientific concepts that are applications of advanced mathematics topics. Advanced-level mathematics is required to explain the mechanism supporting the development of each scientific concept. Mathematics topics include exponential growth, the derivative, logarithms, differential equations, and partial derivatives. Interactive models for population growth feature probabilities that the viewer can adjust to create an animation with pink balls representing population units. These pink balls are used to simulate from 1 to 20 generations of growth. The theoretical population curve and the curve based on the simulation can be displayed and compared on the same graph. Also found at this site are simple and complex simulations with graphs for the propagation of disease. Included is an explanation of the mathematics that supports each simulation. There is a note to high school students and teachers about the importance of mathematics for the study and understanding of modern biology. Links to related sites are provided. Winner, ENC Digital Dozen, November 1998. (Author/JRS) ENC-013226

Applying Science

Family Learning Events: Science and Math Activities Through a Literacy Approach

Grades K-4
1998
Author: Texas Statewide Systemic Initiative (TSSI)



The instructions and activities in this book provide guidance for hosting a family learning event in science and math. Integrated throughout the activities are language arts skills as well. Four learning event themes are featured: Crawly Creatures, All Full of Air, Seeds and Things, and Water Works. Each learning event involves the use of stations where families work together on an activity. When students complete an activity, their "learning passports" are stamped or fixed with a sticker. All necessary planning materials are included in the book, along with ideas for group sharing, on both blackline master and computer disks. Instruction sheets, flyers, invitations, and parent evaluation forms are available in both English and Spanish. Each of the four events includes a listing of Texas standards met, a list of materials needed, and a selection of books that complement the activities. Sample activities from the Crawly Creatures event include making boxes for viewing bugs, estimating the number of bugs that will fit in different-sized boxes, and writing a group story about insects. (Author/SSD) ENC-018310

Ordering Information
Educational Products, Inc., 1342 North I-35 East Carrollton, TX 75006
Email: sales@educationalproducts.net
Fax: (800) 685-2461 / Toll-free: (800) 635-5345
$29.99 per book (loose-leaf) with 2 computer disks

MAD Labs

www.madsci.org/labs
Grades K-12
1998
Author: The MAD Scientist Network
Publisher: Washington University in St. Louis

This web site has become a comprehensive online information resource for science. More than 700 volunteer scientists from all over the world donate their time and expertise to answer science questions sent to them via email. Most of the questions are submitted by K-12 students, either on their own initiative or as part of a class assignment. The questions are reviewed before being forwarded to experts with advanced knowledge in an appropriate field. Ninety percent of questions are answered within two weeks, although most are answered much sooner. Answers often include citations and links to additional information on the Internet. A searchable archive of past questions and answers is available. The library area includes extensive links to other science reference sources and education sites. Additional features include an archive of lab investigations that can be performed at home or in the classroom and links to a "visible human" section where users can view images and movies of 3-D cross sections through the human body. (RJD) ENC-016149

Ethics and Values in Pre-College Science Instruction

Onlineethics.org/edu/precol/classroom
Grade K and up
1999
Author: Michael S. Pritchard, Theodore D. Goldfarb
Publisher: The Online Ethics Center for Engineering & Science

This online document discusses how science intersects with ethics and values and provides guidelines and examples of how to incorporate ethics into classroom lessons. The first section of the paper reflects upon what the term ethics encompasses and discusses ways that ethics can be taught. Case studies are used to illustrate lapses in scientific ethical behavior, including fraud, data manipulation, and mistreatment of human subjects. The second section suggests ways to design classroom lessons that incorporate ethics and values into secondary school classroom teaching. Twenty-three model lessons are categorized based upon the way they relate to ethics and values. The third section lists books, articles, videos, and web sites as resources teachers can use when preparing for classes that integrate ethics and values into the teaching of science. In a sample lesson, students discuss the ethical issues surrounding the collection, evaluation, and analysis of data from a landfill located next to an elementary school. The discussion section stresses the importance of having community members who are scientifically literate so that they can responsibly evaluate the experts' reports. (Author/JR) ENC-017287

Population Growth and Balance

www.arcytech.org/java/population
Grades 5-10
2000
Author: Jacobo Bulaevsky
Publisher: Arcytech Research Labs

Student visitors to this web site can use a mathematical model to conduct simulation population dynamics experiments. The site contains background information about the basic life requirements for oak trees, squirrels, and red-tailed hawks and emphasizes the ways that the three organisms interact. Information is also provided on the mathematics involved in modeling population dynamics through exponential and logistic growth curves. Visitors use the scientific method and a population dynamics computer model to find the answers to questions about the three populations. The model allows users to set variables such as the number of each type of introduced organism, the year that they are introduced to the community, and the birth rate of the squirrels and the hawks. The students can then start the model and look at an overhead view of the community to see how the woodland changes physically. The data generated in the model are continuously added to a chart as well as to a graphic display of the three population sizes. Appendices provide additional background information. Winner, ENC Digital Dozen, October 2000. (Author/JR) ENC-017846

Decisions, Decisions

ddonline.tomsnyder.com
Grades 6-12
2000
Author: Hedrick Ellis, Holly Brotchmar
Publisher: Tom Snyder Productions, Inc.

At this web site, students can read point-counterpoint arguments on today's controversial issues in science and social studies. Each month, a new current events topic is addressed; topics range from cloning to the death penalty. Students watch short videos and then take on the roles of legislators faced with controversial bills, discussing the issue with their classmates. During the activity, the students analyze the situation, determine their goals, and consider their options before they make decisions and consider the consequences. Teachers can download the pdf files with memos and quizzes that check the students' understanding of terms and concepts explained in the videos and the memos. One issue that students investigate is the use of animals in product testing. Different arguments include the point that human health is helped through animal testing, and that it is cruel to expose animals to painful tests. Students are encouraged to post their opinions on a virtual bulletin board, contact government officials, and visit other sites for additional information. (Author/JR) ENC-016967

Waste Management

Series: Integrated Mathematics, Science and Technology (IMaST)
Grade 7
1999
Author: Center for Mathematics, Science, and Technology Education

The waste management activities in this curriculum unit are designed to be coordinated by the mathematics, science, and technology teachers. Students use a problem-solving process to make informed decisions about reducing, reusing, and recycling solid waste and to rethink the ways that solid waste is managed. The unit is part of the standards-based IMaST program, which was created to promote experientially based, hands-on learning for students and to facilitate teaming among teachers from three or more disciplines. The program is built on major themes that are presented in separate modules. It uses the learning cycle approach with problem solving as the key instructional technique. The waste management module includes activities in mathematics, science, and technology related to the amount, composition, and production of waste materials. The activities in the student book explore topics such as the surface area and volume of a rectangular prism or the analysis of compost. The book outlines each unit, explains the problem-solving process, and organizes the activities into mathematics, science, and technology sections. Also provided are background information, activity directions, and reflection questions. The student journal has questions, tables, and graph paper to help students record their answers and results. The teacher's resource binder explains how to implement the IMaST program, how it correlates to the national standards in each discipline, and how the mathematics, science, and technology activities can

be scheduled to coordinate among the team of teachers. Directions and teaching suggestions are given for each portion of the activities as well as assessments and grading criteria. Also in the resource binder are profiles of related careers, such as an administrative services manager or a stockbroker. (Author/JR) ENC-018078

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$15.48 per student text (paperback)
$51.99 per teacher's resource binder

Chemistry That Applies, 8th, 9th, or 10th Grade

Series: New Directions Science Units
Grades 8-10
1991
Author: staff writers, Theron Blakeslee, Leona Brownsin, Margo Chapin, Deborah Herbitt, Yvonne Peek, Elma Tsuneiuda Thiele, Joe Vellanti

The sequenced chemistry lessons in this teacher's guide and accompanying student text provide students with opportunities to explore various everyday chemical reactions. The unit is part of a series that features thematic, real-world, and hands-on activities based on Michigan Essential Goals and Objectives for science education. This chemistry unit consists of four clusters, each building toward a comprehensive understanding of how changes in matter relate to atoms and molecules and energy. Four basic reactions are explored: burning, rusting, the decomposition of water, and the volcano reaction of baking soda and vinegar. In cluster one, students are asked to develop descriptions of various substances and changes that occur in them. In cluster two, students consider what happened to the weight of the substances during the reactions. Students make predictions about weight changes and then weigh the starting substances and the ending substances to check their predictions. In cluster three, students construct explanations for both the formation of new substances and the law of the conservation of matter. In cluster four, students explore the energy changes that take place between reactants and products and use separate energy equations to express these changes. In a sample activity, students build molecular models using marshmallows and toothpicks to show how rust forms from iron and oxygen molecules. The teacher's guide features a planning guide, a short overview of each lesson, and classroom management tips for carrying out each activity. Appendices include reproducible blank charts for lessons and suggestions for optional readings. (Author/YK) ENC-016917

Ordering Information
Battle Creek Area Mathematics and Science Center Unit, 765 Upton Avenue, Battle Creek, MI 49015
(616) 965-9400 / Fax: (616) 965-9589
www.maconstor.org/cgi-bin/master_browse.cgi?name=BattleCreek
$18.00 per teacher's guide and student text

BioBlast: Better Learning Through Adventure, Simulation, and Telecommunications

Grades 8-12
1999
Author: NASA Classroom of the Future

In this problem-solving simulation, students are placed in a lunar research facility in which they work to design and test a model for a plant-based life support system able to sustain a six-person crew for three years. The standards-based CD program seeks to motivate student interest in research, encourage students to investigate current NASA issues, and provide a scientific inquiry context for the use of computer-based tools and hands-on laboratory experiments. In the simulation, students study plant production, human requirements, and resource recycling as they investigate how Earth's biological systems can be replicated in a plant-based space habitat. In one activity, students use critical thinking, math processes, and chemical formulas to compute the production and consumption of materials in respiration and photosynthesis by the crew members and plants. The students gather data from the CD's movies, documents, and images and keep notes in their electronic journals to help them make their decisions during the simulations. They make choices about system parameters such as the growing conditions of the crops, waste disposal capacities, and the number of male and female crew members. Some of the activities require the students to use the spreadsheet templates that are available on the disc. Students can also connect to a NASA ask-an-expert web page. Accompanying the CD-ROM are a video that provides an overview of the program and a teacher guide with implementation instructions. (Author/JR) ENC-018520

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www.core.nasa.gov
$5.00 per video with educator's discount
$60.00 per CD-ROM package (Windows)

Your Genes, Your Choices: Exploring the Issues Raised by Genetic Research

ehrweb.aaas.org/ehr/books/index.html
Series: Science + Literacy for Health Project
Grades 9-12
1999
Author: Catherine Baker
Publisher: American Association for the Advancement of Science

This web site hosts the online version of a book that describes the Human Genome Project, the science behind it, and the ethical, legal, and social issues that are raised by the project. The text explores the many ways that genetic research is changing the world in which we live. Topics include prenatal testing, DNA fingerprinting, genetically altered foods, gene therapy, and human cloning. Each chapter begins with a scenario that invites readers to make a decision about whether to participate in or utilize a new technology. Additional information then illustrates how difficult it can be to make such decisions. A sample scenario introduces readers to Priya, a young woman who is wondering if she should be tested for

the gene for Huntington's disease. The text describes chromosomes, dominant and recessive inheritance, and the importance of genetic counseling. Other chapters explain prenatal testing in the context of cystic fibrosis and the agricultural impact of genetically engineered bovine growth hormone. (Author/LCT) ENC-017057

PhysLINK.com: The Ultimate Physics and Engineering Reference and Education Online Source

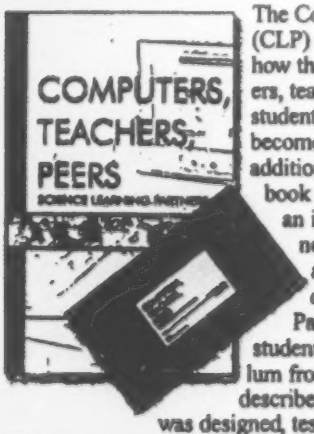
www.physlink.com
Grade 9 and up
2000
Author: Anton Sherwood
Publisher: PhysLINK.com

Anyone interested in physics can visit this web site to find tools, historical perspectives, and information about physics concepts and opportunities. The site features editorials and current news articles; a reference section with tables of prefixes, the Greek alphabet, and constants; and an online forum where visitors can discuss physics concepts or homework problems. Also available is a section listing career opportunities in physics. The site offers evaluations of science software and books and a searchable archive of ask-an-expert questions. Additional resources include information about the Young Scientist of the Year Award, physics jokes, and quotes from famous scientists. Winner, ENC Digital Dozen, February 2000. (Author/JR) ENC-016492

Understanding Science News and Issues

Computers, Teachers, Peers: Science Learning Partners

Grade pre-K and up
2000
Author: Marcia C. Linn, Sherry Hsi



The Computer as Learning Partner (CLP) project is an initiative to study how the interaction between computers, teachers, and peers can help students build on their ideas and become lifelong science learners. In addition to the project findings, this book and companion video provide an instructional framework that new partnerships can use to get a head start on curriculum design. Section I introduces Pat, Chris, Lee, and Sasha, four students who follow the CLP curriculum from grades 8-12. Section II describes how the CLP curriculum was designed, tested, and refined to promote lifelong science learning. This section also presents four pedagogical principles: making science accessible, making thinking visible, helping students learn from each other, and promoting lifelong science learning through project-based learning. Section III examines science learning from the perspective of the four students named above and compares their descriptions with evidence from their science class performance. Section IV discusses how information gained from the CLP project can be used to design effective instruction that emphasizes making technology a learning partner. The video shows physics students working with a classroom teacher to learn science and engaging in real-time data collection, graph interpretation, classroom debate, and critique of Internet evidence as they study heat, temperature, light, and energy conversion. The text is also supplemented by a CD-ROM (included with the book) and a companion web site that offer the complete CLP curriculum, lesson plans, and copies of assessments. (Author/LCT) ENC-017665

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Beyond 2000: Science Education for the Future—A Report with Ten Recommendations

www.kcl.ac.uk/depsta/education/be2000/index.html
Grades K-12
1998
Author: editors, Robin Millar, Jonathan Osborne
Publisher: King's College, London

This report, available for download online as a pdf document, presents the outcome of a 1998 seminar series to consider and review the form of science education required to prepare young people for life in 21st-century England and Wales. The seminar series addressed four principal questions: What are the successes and failures of science education to date? What science education is needed by young people today? What might be the content and structure of a suitable model science curriculum? And what problems and issues would be raised by the implementation of such a curriculum and how might they be addressed? Recommendations include a clear statement of the rationale for science study and what should be learned, the incorporation of applied science and technology within the curriculum, and the use of a wide variety of teaching methods and performance assessments. (Author/LCT) ENC-014118

The Why Files: Science Behind the News

whyfiles.news.wisc.edu
Grades K-12
1996
Author: National Institute of Science Education
Publisher: University of Wisconsin

Twice monthly, this web site presents a new feature on the science (and math, engineering, and technology) of everyday life. Topics range from outer space to cellular biology, from dinosaurs and dragon lizards to the statistics of political polling. The Cool Science section provides background and technical information about the featured image. The Sports section provides questions and answers about particular physical concepts. An archive section is included. Winner, ENC Digital Dozen, August 1999. (Author/DEB) ENC-008655

Science and Creationism: A View From the National Academy of Sciences

Grade 8 and up
1999
Author: National Academy of Sciences

This booklet presents three strands of scientific evidence that support the theory of evolution, with brief analyses of the contrasting creation science arguments. The three strands include the origins of the Earth, biological evolution, and human evolution. Scientific evidence cited in the booklet comes from the fields of astronomy, paleontology, and molecular biology as well as genetics and anatomy. The authors conclude that science is but one way of acquiring knowledge about the world, but to suggest that other methods of understanding deserve equal time in the science classroom is to misunderstand what science is and how it works. An appendix answers frequently asked questions about evolution and creation. (Author/JR) ENC-017639

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www.nap.edu
$9.95 per book (paperback)

Living and Working in Space: The Countdown Has Begun

Grades 3-10
1997
Author: executive producer, Steven R. Heard

On this video is a compilation of clips that explore such topics as spacesuits, rovers, and living in microgravity. For each video segment, suggested lesson plans and activities are provided in the education guide. A story involving famed teacher Jaime Escalante (profiled in the film *Stand and Deliver*) and one of his students is interwoven with imaginative vignettes that explore the humor and drama of daily life away from Earth. Guest stars include Billy Bob Thornton, Kathy Bates, and Jeffery Tambor. Each segment begins with an imaginative story that illustrates the realities of life in space, including planning a vacation, starting a new sports business, and doing the laundry. This introductory story is followed by scientific background explanations and a look at current research for each topic. Dozens of space professionals, from spacesuit designers and life systems engineers to interior decorators and architects, show how spacesuits work, how to grow food in space stations and lunar habitats, and how to construct huge habitats in space. In a sample segment, students learn about the known effects of microgravity on the systems of the human body and what measures astronauts undertake to counteract them. (Author/YK) ENC-017796

Ordering Information
Foundation for Advancements in Science and Education, 4801 Wilshire Boulevard, Park Mile Plaza, Suite 215, Los Angeles, CA 90010
Email: [redacted]
(213) 937-9911 / Fax: (323) 937-7440 / Toll-free: (800) 404-2327x267
www.fasenet.org
$19.95 per video (includes a science education guide)

Talking About Sex: A Guide for Families

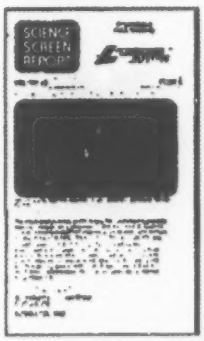
Grades 5-9
1996
Author: executive producer, Marilyn Kraemer

The information and prompts in this kit are designed to help families comfortably communicate about sex and sexuality. The animated video uses humor to illustrate unsuccessful and effective communication techniques in sample conversations between teenagers and adults. Other conversations among teenagers emphasize their common concerns, such as sexual orientation, and help replace misconceptions with factual information. The parent's guide answers commonly asked questions and provides information about topics such as body changes, pregnancy, and sexually transmitted disease. The kit also contains a teacher's guide with guidelines for presenting the material in two class sessions and in a session that includes parents. It suggests a lesson plan with discussion questions, homework assignments, and a knowledge questionnaire. The accompanying activity book has puzzles and exercises for the students to review what they learned in the video. Anatomically correct diagrams explain the changes that occur in males and females as they go through puberty. (Author/JR) ENC-017194

Ordering Information
Planned Parenthood Federation of America Marketing, 810 Seventh Ave., New York, NY 10019
Fax: (212) 261-4352 / Toll-free: (800) 669-0156
$19.95 per kit (1 video, 2 guides, 1 activity book) Quantity discounts available. Contact vendor for information about pricing and Spanish language resources.

Technology and Science for a Safer Tomorrow

Series: Science Screen Report! Millennium Series
Grades 5-9
1999
Author: writer, producer, Deborah Crumpton



Middle-grade classrooms can use this video and accompanying teacher's guide to explore current technologies that preserve our safety and security, from surveillance cameras to new rescue and disaster prevention tools. The set is part of a seven-program series that introduces students to the future of medicine, fitness and recreation, transportation, and security issues and robots. Each program offers narratives and visions of science, engineering, and medicine at work using live-action videos and computer graphics. This program discusses new ways to keep safe from criminals, terrorists, and earthly disaster. Segments show how microphones may be used to quickly locate the source of gunshots and how a footprint can be used to make a positive identification by analyzing the pressure exerted by the human foot. Students also see how fires are studied in large building test facilities, and how people are studied in panic simulations that mimic human response and movement. The accompanying teacher's guide provides a program overview, vocabulary words, and career opportunities. After viewing this video program, students are encouraged to write an essay in which they describe the future as they imagine it to be. (Author/YK) ENC-017843

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www.arvideo.com
Free video through corporate sponsorship

The Food System: Building Youth Awareness Through Involvement

Grades 5-12
1999
Author: Alison Harmon, Bianca Harmon, Audrey Marutzki

This guidebook introduces readers to the concepts of the food system and related issues. Topics covered include food system inputs, food production and distribution, food access and consumption, and ways to sustain the local food supply. For each topic, the book includes background information, activities, and suggestions for involving students in various aspects of the food system. It also contains thought-provoking questions and resources for gathering additional information. Activities emphasize the development of critical thinking skills for making informed decisions. Each activity includes sections on background information, a list of materials, and procedures, as well as discussion questions, suggestions for extension activities, and resources. In a sample chapter on food transformation, students learn about some basic food science principles, food processing, and the importance of food safety. They also explore examples of food-borne pathogens, government agencies that monitor food safety, and food processing at home. The book also provides reproducible activity sheets for students. A glossary is included. (Author/YK) ENC-018846

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$15.00 per guidebook (spiral-bound)

Issues, Evidence & You

Series: Science Education for Public Understanding Program (SEPUP)
Grades 7-9
1996
Author: Lawrence Hall of Science, University of California at Berkeley
Publisher: SEPUP, Lawrence Hall of Science

Included in this kit are the materials for a full-year, inquiry-based interdisciplinary chemistry course that uses environmental issues to motivate students. The course is divided into sections that cover the safety of the water supply, the availability and use of a variety of natural and invented materials, and energy sources and use. In a fourth section, students evaluate the environmental impact of building a factory in an island community. In a sample activity, students use a microbial growth medium to prove that a sample of untreated water contains microorganisms; in another, they examine leachates from both a simulated unregulated dump and a regulated landfill in order to understand issues related to the safety of landfills. Each activity includes data processing suggestions to help students analyze, interpret, and display data. The teacher's guide provides an introduction to the SEPUP approach and guidelines for each activity that include an overview, learning objectives, advance preparation and safety notes, transparency masters, student reading assignments, and extension activities. The components of the assessment system include embedded assessments, journals, and rubrics. A materials kit is also available. (Author/LCT) ENC-008015

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www.lab-aids.com
$125.00 per teacher's guide (loose-leaf with binder)
$31.90 per textbook (library binding)
$4,895.00 per kit—includes teacher's guide, 32 student books, resource kit (consumables for 5 classes of 32 students each, consumables for 32 students). All pieces are also available individually. Contact vendor for refills and replacements.

Chemistry Connections

Series: Science in the News
Grades 7-12
2000
Author: Cable News Network, Inc.

Intended as a supplementary technology resource for the Holt Chemistry: Visualizing Matter edition, this video provides 32 segments of CNN news reports that relate to textbook topics. A teacher's guide provides an overview of each program, suggestions for post-viewing activities, and references for further research. Also included is a booklet of reproducible worksheets (with answer keys) that assist students in analyzing and evaluating the information they have viewed. Sample footage follows a reporter as she uncovers common household chemicals that can harm people and the environment. The report identifies proper disposal methods and discusses how local communities have developed programs to address this problem. Extension activities ask students to inventory their homes for harmful chemicals and determine if the labeling of these products is appropriate. Other segments feature current research on global warming and a high school chemistry class that creates superconductors. (Author/JG) ENC-018876

Ordering Information
Holt, Rinehart and Winston, Inc., Order Fulfillment, 6277 Sea Harbor Drive, Orlando, FL 32887
Fax: (800) 269-5232 / Toll-free: (800) 225-5425
www.hrw.com
$47.15 per set (includes video, teacher's guide, and set of worksheets)

The Weather Book: An Easy-to-Understand Guide to the USA's Weather

Grades 7-12
1997
Author: Jack Williams
Publisher: Vintage Books

Students can read this book to learn about today's science of weather and climate, ranging from issues such as what makes the sky blue to how a tornado gets its twist. The book is an outgrowth of *USA Today*'s Weather Page and its graphics. The author explains the country's major weather events and how weather happens. The first part of the book begins with some science

basics in which students learn how the sun causes weather, why the winds blow, and what makes rain. Subsequent chapters examine various kinds of weather, including the extremes of the Earth's natural water cycle, thunderstorms and tornadoes, and hurricanes. Additional topics include sky watching (clouds, halos, and contrails) and how to predict the weather. A section on the future of Earth discusses how we might be changing the planet's climate through the greenhouse effect and the ozone hole. Each chapter features profiles that introduce students to the nation's top atmospheric scientists. In a sample chapter, students learn where and how hurricanes begin and how hurricanes are predicted. Students meet a flight meteorologist who flies into the eye of a hurricane to produce better hurricane forecasts. The book also provides a state-by-state guide to weather records and events, a bibliography, and an index. (Author/YK) ENC-017347

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AMS-Project ATMOSPHERE, 1200 New York Avenue NW, Washington, DC 20005
(202) 683-9337 / Fax: (202) 683-9341
$20.00 per book (paperback)
$59.95 per set of 30 transparencies

Cloning: How and Why

Grade 8 and up
1998
Author: writer/producer, Bill Stonehenge

Viewers of this video learn about the cloning of mammals and are challenged to consider the future implications of this revolutionary technology. The video reviews the history of cloning of mammals, explains the scientific principles underlying this method, and highlights the ongoing research on biotechnology. The program then lists some of the unanswered questions in this new field and explains the importance of searching for the answers to them. Also addressed is the public's interest in cloning, particularly in the area of using this technology to produce human insulin from cloned cows. Controversial issues regarding ethics of human cloning are also discussed. One such issue is whether using cloning to make pregnancy more probable should be allowed or encouraged. Included in the program are scenes from cloning research laboratories and excerpts of scientific presentations. The video is accompanied by a text version of the program script. (Author/FCM) ENC-018861

Ordering Information
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www.humboldt.com
$84.00 per video and text

Genetic Engineering: A Reference Handbook

Series: Contemporary World Issues
Grade 9 and up
1999
Author: Harry LeVine III

Part of the Contemporary World Issues series, this book discusses the issues surrounding genetic engineering, including its effects on the environment, the ethics of gene therapy, privacy issues, and the issue of human genetic engineering. The series addresses vital issues in today's society through narrative text that reflects the competing or concordant philosophies from a variety of primary sources. This book begins with a brief history of the genetic engineering revolution, the Human Genome Project, and basics of genetic engineering. Subsequent chapters discuss possible impacts of gene therapy, ecological consequences of the widespread use of genetically modified organisms, and renewable fuels. The book examines the economic impact of the new genetic technologies on the developing and underdeveloped nations of the world. Other issues addressed include maintaining the privacy of an individual's genetic information and possible innovations ahead for genetic engineering. Biographical sketches profile leading contributors to the field, including Rosalind Franklin, Louis Pasteur, and James Watson. The book provides selected resources for those who wish to delve deeper into the subject. (Author/YK) ENC-018014

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Genome Gateway News

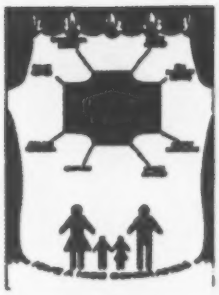
www.nature.com/genomics/news/index.html
Grade 9 and up
2000
Author: Nature Publishing Group

At this web site are news articles from *Nature* and *Nature Genetics*. The articles discuss topics such as research progress, policy issues, and ethical implications of genome sequencing. The articles are grouped into topics such as the sequencing of nonhuman genes, national genome projects, and the Human Genome Project. Visitors can choose to view the articles online or in pdf format. One article in the genome ethics section discusses the different viewpoints about protecting the privacy of study participants' family members. The article addresses the options of obtaining waivers from family members versus the task of enrolling family members as human subjects in the study. Cited is a previous case in which a father felt that his privacy was violated when one of his children answered questions about him on a questionnaire. This site is part of a larger site that has a library of original papers, descriptions of applications of sequencing research, and links to related web sites. Winner, ENC Digital Dozen, October 2000. (Author/JR) ENC-017994

Chances' Choices

Grades 10-12
1997
Author: Edward N. Glass

This interdisciplinary curriculum unit uses the story of the Chance family as the focus for studying human genetic conditions and for discussing their related social, economic, and ethical issues. The extended family saga begins when Paul and Stacy Chance give birth to their daughter, who was diagnosed with phenyketonuria (PKU). Each of the 12 scenes introduces the characters, concepts, and conditions. A box listing specific objectives heads each scene, followed by



background information and the lesson guidelines. Questions for discussion, activities for assessment and enrichment, and references follow each scene. Assessments include options such as portfolios and writing assignments. In one of the scenes, Paul has a heart attack and is diagnosed with familial hypercholesterolemia (FH). Overheads show the inheritance pattern of autosomal dominant traits, the faulty receptor mechanism resulting from FH, and a comparison of clear versus clogged arteries. Teachers can find background information about the disease and relevant testing, treatment, and management techniques. The scenario goes on to reveal that Paul's late brother had fragile X syndrome and that his two sisters have opposing views about testing for possible genetic disorders. Students are asked if employers should require testing and if Paul's sister should be persuaded to have her blood tested for FH. Suggested research topics include investigating the environmental effects on a person with FH and studying defects caused by abnormal numbers of sex chromosomes. Writing assignments, portfolio projects, enrichment activities, and guest speaker topics extend the discussions about nutrition, cholesterol, and heart disease. (Author/ JR) ENC-017836

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Creating Scientific Awareness of the Environment

Habitats of the World

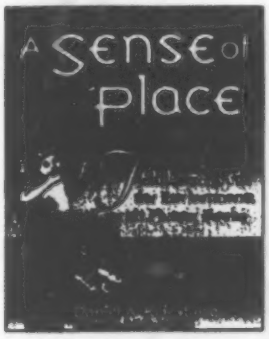
Series: *TLC Elementary School*
Grades: K-5
1999
Author: producer/writer, Megan Schreiber Carter

In this video, part of the TLC Elementary School series, students learn about five different habitats representing Earth's multiple geographic characteristics. The series is designed to unfold the wonders of the world to primary school children. Because each program is divided into short segments, teachers can choose what parts to incorporate into their existing lesson plans. Support resources for the series are available on the Discovery Channel School's online site. This video illustrates habitats ranging from the tropical rainforest to the polar ice in Antarctica. It shows how each habitat is influenced by climate, altitude, and the resident organisms. Viewers see how animals, such as crocodiles and penguins, are adapted to their habitats. The video emphasizes that since the components of each ecosystem are so tightly interrelated, any changes have widespread effects. The video is accompanied by a guide that includes tips for using the program in the classroom. The guide suggests stopping the tape so that students can draw a summary diagram, giving the students opportunities to reflect on the new information in the segments, and asking the students to present a brief television news report to the class. The online program guide contains an activity in which students work in groups to produce research reports about habitats around the world. An evaluation rubric, extension ideas, and a suggested reading list are provided. A glossary defines the vocabulary words and pronounces them out loud. Academic standards and benchmarks for the activity are identified. (Author/JR) ENC-018204

Ordering Information
Discovery Communications Inc, PO Box 4827, Florence, KY 41022
Fax: (859) 727-0918 / Toll-free: (800) 572-2404
www.discoveryschool.com
$49.95 per video

A Sense of Place: Teaching Children About the Environment with Picture Books

Grades: K-6
1999
Author: Daniel A. Kriesberg
Publisher: Teacher Ideas Press



This book is designed to help integrate children's literature and hands-on activities to increase students' awareness of their connections to the Earth. Each chapter begins with an introduction, followed by an annotated bibliography of picture books selected to reinforce the concepts covered in the chapter. The chapters also include a variety of environmental education activities, a language arts project, and activities to integrate math and art. The author points out that place-based environmental education can be used to meet state and national standards. The topics addressed in the book develop students' geographical and scientific observational skills and provide opportunities for them to learn about their area's ecology and history. Chapters discuss plant and animal diversity and include techniques for students to engage the community in environmental protection practices. One chapter about ecological relationships, for example, is designed to help students learn cycles within an ecosystem and understand how actions cause effects. The books recommended in this chapter deal with topics such as the food chain, decomposition, and the water cycle. The activities include games, outdoor explorations, and magic. (Author/JR) ENC-016970

Ordering Information
Teacher Ideas Press, PO Box 6633, Englewood, CO 80155
(303) 770-1220 / Fax: (303) 220-8843 / Toll-free: (800) 237-6124
www.lu.com
$23.50 per book (paperback)

Island Explorers Marine Science Program

www.usc.edu/org/seagrant/IE.html
Grades: 1-8
2000
Author: University of Southern California Sea Grant

Sea Grant at USC maintains this web site, which describes the Island Explorers Program and provides two online activities centered on Catalina Island aquatic organisms. The student-centered science curriculum is characterized by hands-on, real-life marine science activities that focus on southern California and Catalina Island coastal environs. Its goals are to promote science literacy and to encourage interest and lifelong learning of the marine sciences, especially for minority students.

In addition, the program informs students of marine science careers and requirements. As part of the overall program, students participate in several field trips to local beaches and aquaria, participate in an Adopt a Beach cleanup, and travel on a research vessel to the USC Wrigley Institute for Environmental Studies (WIES) marine laboratory on Santa Catalina Island. One of the two online activities provides background information and live views of Garibaldi fish. In the other interactive activity, students are asked to identify pictures of animals that eat kelp. Students can find kelp recipes and instructions to make seaweed presses. (Author/JR) ENC-018467

Oceans, Grades 2-3

Grades 2, 3
1992
Author: Lisa Miller Mulcrone
Publisher: Instructional Fair, Inc.

This activity book contains a six-foot-long, black-and-white banner for students to color and reproducible student activity pages that integrate all subject areas based on one theme: oceans. Each thematic unit in the series uses a motivating theme to teach students important skills, using a variety of formats such as bulletin boards, reading and math centers, art projects, and creative writing. Each book includes teacher resource pages full of ideas for bulletin boards, field trips, and parental involvement, as well as creative dramatics, answer keys, and evaluation techniques. In this unit on oceans, students make and display a food chain using pictures of ocean animals on a bulletin board. In sample writing activities, students compare salt water and fresh water using a Venn diagram and write their own songs about the ocean community. In a sample art project, students make fish kites. In a sample science activity, students explore salty water evaporation to find out what happens to ocean water when it is exposed to the sun. (Author/YK) ENC-017424

Ordering Information
McGraw-Hill Children's Publishing, 3195 Wilson Drive NW, Grand Rapids, MI 49544
Fax: (800) 453-2253 / Toll-free: (800) 345-4149
www.mhkids.com
$8.95 per activity book (includes pull-out banner and 2 sticker sheets)

Rain Forest

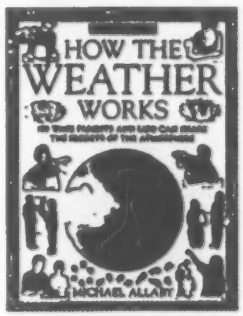
Series: Hands-on Minds-on Science
Grades 2-4
2000
Author: Tricia Ball

The activities, fact sheets, and teacher tips in this activity book focus on life in the rainforest, conservation, and environmental issues. Each book in the Hands-on Minds-on Science series offers activities centered on a different subject and is authored by a teacher who specializes in that field. Every page is perforated so that it can be removed for use as a handout. Some of the pages provide spaces for writing or drawing so that they can be copied and used as student worksheets or journal pages. Each book also includes a glossary and bibliography. In a sample activity in this book, children discuss the types of rainforest animals that can fly or glide from tree to tree. They then construct a model of a flying dragon from the rainforests of Asia using the instructions and the paper template provided in the book. Students then try out their model lizards to see whose can fly the farthest. In another activity, students study their normal classroom practices and look for ways to reduce the consumption of natural resources. (RJD) ENC-016450

Ordering Information
Teacher Created Materials, Inc., 6421 Industry Way, Westminster, CA 92683
Fax: (800) 525-1254 / Toll-free: (800) 662-4321
www.teachercreated.com
$11.95 per activity book (paperback)

How the Weather Works

Series: Reader's Digest Books
Grades 3-8
1995
Author: Michael Allaby
Publisher: The Reader's Digest Association, Inc.



This book provides a complete hands-on guide to recognizing and understanding different types of weather patterns and the factors that cause them. Topics discussed include atmospheric pressure, humidity, and dew points, as well as the physical properties of air, water, and ice. Other topics include the various climates of the world's major biomes, the causes of the different climate zones, and the origin of wind, rain, snow, clouds, and lightning. The book also describes the causes and consequences of more destructive natural phenomena such as tornadoes, hurricanes, and volcanoes. The science behind these phenomena is demonstrated through hands-on experiments and activities that utilize common household materials. In sample activities, students make clouds inside a glass jar, construct their own hygrometer for measuring humidity, and create a model of a tornado inside a glass of carbonated water. In other activities, students study ice erosion by placing wet rocks in a freezer and study the effect of plants on the atmosphere by burning candles in a sealed jar containing water and fresh green leaves. Each book in this series was written with the help of an expert from the field, and the activities range in difficulty from simple to highly challenging. The text describes the scientific principles of each activity in ways intended to promote a higher level of understanding of everyday phenomena and technologies. (RJD) ENC-017417

Ordering Information
Reader's Digest Young Families Inc., Children's Trade Books, The Reader's Digest Association, Inc., Pleasantville, NY 10570
(212) 366-8890 / Fax: (800) 659-2436 / Toll-free: (800) 310-4261
www.readersdigest.com
$24.00 per activity book

Communities In Nature, Grades 4-6

Grades 4-6
1991
Author: Daryl Vriesenga
Publisher: Instructional Fair, Inc.

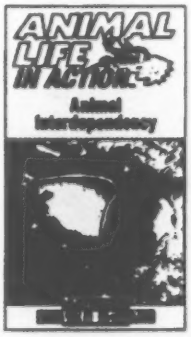
Based on the theme of communities in nature, this activity book contains four full-color posters and reproducible student

activity pages that integrate all subject areas. The posters present an overview of the four communities (pond, forest, desert, and grassland community), the different characteristics of the communities, and the effects on a community when its natural habitat is changed. Using this theme, students make a food chain depicting the food cycle representative of all communities found in nature. They also create a poster about how to save an endangered species. In a sample art project, groups of students make animal puppets and then write and perform skits using their puppets. In a sample science activity, students observe the tiny organisms that are found in pond water using a microscope. For another activity, students choose an animal from the grassland community poster and then describe its adaptation to defend itself from its predator. (Author/YK) ENC-017420

Ordering Information
McGraw-Hill Children's Publishing, 3195 Wilson Drive NW, Grand Rapids, MI 49544
Fax: (800) 453-2253 / Toll-free: (800) 843-8160
www.mhkids.com
$8.95 per activity book (includes 2 pull-out posters)

Animal Interdependency

Series: Animal Life in Action
Grades 5-8
2000
Author: executive producers, Andrew Schlesinger, Tracy Mitchell
Publisher: Schlesinger Media



The footage in this video illustrates the different interactions between animals in the same ecosystem. It explains how the food web circulates energy and enables the recycling of nutrients. Viewers also see examples of symbiosis in parasitic, commensalistic, and mutualistic relationships. In one segment, the video shows how weaver birds get protection from the wasps when the birds build their nest around the wasps'. Bees provide an example of how cooperation within species is a type of interdependency. The video has a feature called Behind the Scenes that shows how a zoo in Thailand is using hogs to nurse Bengal tigers so that the tigers can reproduce more frequently. Another portion of the video shows two students conducting an experiment to investigate the interdependency between goldfish and catfish. The viewers are asked to record their hypotheses and observations when they run the experiments themselves. The accompanying teacher's guide emphasizes the importance of assessing students' prior knowledge, giving students opportunities to reflect on the new information, and focusing on places where the two are inconsistent. It contains a program summary, glossary, and questions for previewing, focus, and follow-up discussions. Lists of Internet and print resources are provided. (Author/JR) ENC-018178

Ordering Information
Library Video Company, 7 E. Wynnewood Road, PO Box 580, Wynnewood, PA 19096
Email: customer@libraryvideo.com
(610) 645-4000 / Fax: (610) 645-4040 / Toll-free: (800) 843-3620
www.libraryvideo.com
$39.95 per video with teacher's guide

Eyes on the Sun

Grades 5-9
1999
Author: National Oceanic and Atmospheric Administration

Developed by the NOAA Space Environment Center, this video presents a brief overview of the effects of the sun's high-energy emissions on the Earth. It is known that solar flares can threaten the health of astronauts and can damage electrical power and satellite communications systems. The Space Environment Center provides real-time monitoring and forecasting of solar and geophysical events and develops techniques for forecasting such disturbances. SEC's Space Weather Operations Center is the national and world warning center for disturbances that can affect people and equipment working in the space environment. (Author/YK) ENC-018281

Ordering Information
Flashback Productions, 4535 North Broadway, Boulder, CO 80304
(303) 545-9955 / Fax: (303) 545-6659
$15.00 per video (also available in Spanish)

Oceans

Series: Discovery Channel School Science Collection
Grades 6-8
1999
Author: Discovery Channel School

This CD-ROM, part of the Discovery Channel School Science Collections, contains interactive activities related to video clips about the oceans. Users move between different virtual buildings to complete a variety of tasks. They can go to the theater to view footage and animation about topics such as coral reefs, fish harvest, and ocean currents. For example, a section about waves and tides combines above- and below-water shots of people surfing with images that show a longitudinal section of a wave moving toward the beach. Students can use the journal option to record notes while watching the videos and can connect to the Discovery School web site. A studio portion of the program contains still slides from the videos that the students can organize into a presentation. In the laboratory venue, the students can participate in a review game, make observations and analyze video footage, and divide selected organisms into categories. The CD's library contains additional information about oceans. Users can browse a list of topics or use the search feature to find articles. The CD-ROM also contains a pdf file with a teacher's guide that explains different ways to use the program and its opportunities for alternative and performance-based assessments. A table summarizes how the materials address the National Standards for Science. Worksheets for the activities are provided in the guide. (Author/JR) ENC-018389

Ordering Information
Discovery Communications Inc., PO Box 6037
Florence, KY 41022
Fax: (859) 727-0918 / Toll-free: (800) 892-3484
www.discoveryschool.com
$49.95 per CD-ROM package (Mac/Windows) Multi-user packages also available. Contact vendor for further information.

BEST COPY AVAILABLE

Biodiversity! Exploring the Web of Life

Series: Windows on the Wild
Grades 6-10
1997
Author: producer and writer, Janet Driscoll Smith
Publisher: World Wildlife Fund

Part of the Windows on the Wild (WOW) series, this kit explores biodiversity and the ongoing environmental crises that are leading to widespread species loss. The series is designed to stimulate critical thinking, discussion, and responsible action on behalf of the environment. It also looks at the different contexts in which biodiversity can be viewed, including the scientific, political, and cultural perspectives. This kit contains a video, a magazine, and an educator's guide. The video, hosted by actors Wilson Cruz and Devon Odessa, defines terms used to describe diversity and ecosystems and shows different scientists explaining ecological concepts. Viewer attention is then drawn to the activities of living organisms in different habitats and the effects of humans' actions on the environment. Students interview people on the street and scientists about their thoughts on the importance of the environment and humanity's responsibility to protect it. The magazine has photographs and articles that illustrate the importance of diversity and present facts about different organisms. The educator's guide has summaries of the video's segments as well as a list of key points and discussion questions. It also offers background information to highlight biodiversity concepts and contains hands-on activities that integrate mathematics skills and ethics with scientific concepts. In sample activities, students explore biodiversity on a hike, keep a journal, and speak to a community group about biodiversity issues. (Author/JR) ENC-018677

Ordering Information
Acorn Naturalists, PO Box 2423, Tustin, CA 92781
(714) 838-4888 / Fax: (800) 452-2882 / Toll-free: (800) 422-8886
www.acornnaturalists.com
$24.95 per kit (includes video, educator's guide, and poster)
Include $5.00 for shipping and handling.

The Birth of Earth and Ancient Oceans

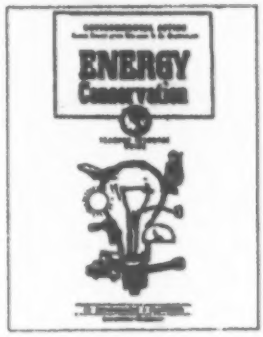
Series: Planet of Life
Grades 6-12
1998
Author: producer, Kenji Shinpoon

Produced as part of the Planet of Life series by the Discovery Channel, this video covers the emergence of life on Earth and early life forms in the ancient oceans. The series is intended to explore the birth, evolution, and future of life on Earth. The first segment of this video explores the primordial planet and describes how life emerged from a sea of toxins. The topics covered in this segment include formation of the moon, the oceans, and the atmosphere, along with the formation of DNA and the evolution of bacteria. The second segment describes the primordial oceans and the earlier life forms and explains the transition of life from the sea to the land. Each segment ends with answers to study questions that are introduced at the beginning of the program. Also included in each segment are activity suggestions and related resources. The video provides computer animations of various primitive life forms, DNA molecules, and cells. An accompanying teacher's guide includes discussion questions and vocabulary sections. (Author/FCM) ENC-018142

Ordering Information
Discovery Communications, Inc., PO Box 6027, Florence, KY 41022
Fax: (859) 727-0918 / Toll-free: (800) 895-3484
www.discoveryschool.com
$49.95 per video

Energy Conservation: A Student Audit of Resource Use

Series: Environmental ACTION
Grades 6-12
1998
Author: developed by E2: Environment & Education



Students and teachers can use this set of books to explore how energy choices impact human health and the environment. It is part of a series designed to promote awareness of environmental issues, to encourage practical application of knowledge and skills in issue resolution, and to build the knowledge and skills needed to investigate, analyze, and resolve environmental problems. Each module provides a variety of activities: explorations, analysis, and experimenting with alternative practices. At the conclusion of each module, students must propose specific actions for creating a healthier environment, including writing and presentating a proposal. In this module on energy conservation, based on an overview of environmental issues involving energy, students conduct an energy audit of the school. They investigate ways to curb waste, improve efficiency, and promote conservation, and end the unit by proposing changes. In a sample activity, students are encouraged to learn how to read and analyze gas and electric meters and bills, including how to calculate energy use and cost. A follow-up activity sends students home to compare seasonal energy use based on past records and share energy-saving plans for reducing charges by ten percents. Throughout the activities, students are encouraged to work in cooperative action groups. The teacher's resource guide provides additional teacher resources along with assessment tools and suggestions for cross-curricular extension activities. The blackline masters for all activities are located at the end of the teacher's resource guide. (Author/YK) ENC-014305

Ordering Information
Dale Seymour Publications, 4350 Equity Drive, PO Box 3649, Columbus, OH 43216
(800) 237-3142 / Fax: (800) 393-3156 / Toll-free: (800) 321-3106
www.pearsonlearning.com
$15.35 per teacher guide (paperback)
$4.55 per student edition (paperback)

The Insect World

Series: Planet of Life
Grades: 6-12
1998
Author: producers, Kenji Shinyama, Hirohiro Hasumoto

Part of the Planet of Life series described in a preceding entry, this video explores the properties of insects, including their success in adaptation, their cooperation with flowering plants, and their well-organized communities. Topics covered include communication of honeybees, the collective behavior of ants, and defense mechanisms of moths against bats. The program also explains how insects have survived through the ages, while entire families such as dinosaurs became extinct. Additional topics include how insects' size has affected their survival rate and how their compound eyes can perceive ultraviolet light. The video contains questions and discussions for the classroom as well as interviews with scientists. A teacher's guide contains discussion questions and vocabulary sections. (Author/FCM) ENC-018194

Ordering Information
Discovery Communications, Inc., PO Box 6027, Florence, KY 41022
Fax: (859) 727-2958 / Toll-free: (800) 572-2404
www.discoveryschool.com
$49.95 per video

American Plastics Council

www.ameriplas.org/index.html
Grade 7 and up
2000
Author: American Plastics Council

The American Plastics Council (APC) maintains this web site to educate teachers and students about the benefits of plastics, their uses, and their environmental attributes. APC's mission is to demonstrate that plastics are a responsible choice in a more environmentally conscious world. The site highlights the physical properties of plastics, their role in health and safety, and recycling as related to the environmental performance of plastics. The Newsroom section of the site offers the latest news and events about plastics, satellite media tours about the benefits of plastics, and research reports that highlight the role of plastics in the reader's world. The Classroom section provides a link to the Hands-On Plastics web site that presents educational background materials about plastics and downloadable classroom activities. The Environment section features detailed information on the positive contribution of plastics to the environment, an explanation of some of the key issues affecting plastics and the environment, and links to other relevant resources. Visitors learn about the history of plastics, how to increase plastics recycling, and how plastics are making major contributions to the world of athletics. (Author/YK) ENC-018109

Environmental Science: Earth As a Living Planet

Grade 10 and up
2000
Author: Daniel D. Chiras, Edward A. Keller

This textbook provides an updated introduction to important and useful concepts in the study of the environment. Topics covered include basic issues in environmental science, ecological communities, and sustaining living resources, in addition to fossil fuels and the environment, global warming, and environmental economics. The book also discusses how our planet works as a system, what our values are, and which potential solutions are socially just. Each chapter begins with a statement of learning objectives and a case study that presents important questions on the subject matter. Special learning modules provide more detailed information concerning a particular concept or issue. Each chapter ends with a discussion of an environmental issue with critical thinking questions for the students. In a sample chapter, students learn about the greenhouse effect, the global warming controversy, and potential effects of global warming. Each chapter also includes suggestions for further reading and Internet resources. A glossary and an index are included. (Author/YK) ENC-018873

Ordering Information
John Wiley and Sons, Inc., One Wiley Drive, Somerset, NJ 08875
(908) 469-4400 / Fax: (732) 302-2300 / Toll-free: (800) 225-5945
www.wiley.com
$59.95 per book (hardcover)

Water on the Web

www.nrri.umn.edu/wow/index.html
Grade 10 and up
2000
Author: Natural Resources Research Institute
Publisher: Department of Education, University of Minnesota, Duluth

At this web site, students will find hands-on science activities designed to introduce basic science concepts through lessons that use the aquatic environment and real lake data. Directed studies allow students to apply and learn concepts through direct, guided experiences, while inquiry lessons provide a more open-ended opportunity for students to discover the same concepts. The student and teacher lesson plans are organized into six sequential components that include knowledge base, experimental design, data collection, data management and analysis, interpretation of results, and reporting results. The lesson plans contain introductory information as well as a list of expected outcomes, materials, and links to related sites. The site also contains online tutorials that explain concepts in limnology, navigation on the site, and how to use the computer program EXCEL for data analysis. Movies in the limnology tutorial show how salinity and temperature affect water density. Winner, ENC Digital Dozen, May 2000. (Author/JR) ENC-016975

Placing Science Learning in Context

Teaching Young Scientists, Grades K-1: Curriculum Linked Integrated Units

Grades: K-1
2000
Author: Karen Clemens Worrick

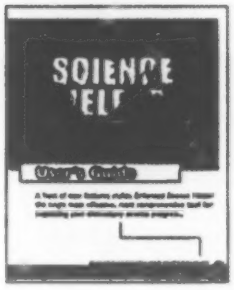
Teachers can use this activity book as a source of ideas and lesson plans to help students learn about science and explore their world. The book's five units feature activities on the world around us, bats, and penguins, as well as on backyard creatures and tide pools. Each unit includes background information for teachers, a list of literature resources, lesson plans, and activity ideas. The activities are intended to develop basic scientific

skills but also to link with other disciplines such as math, art, and social studies. Many come with reproducible activity worksheets that can be copied and distributed to students. In a sample activity, students match pictures of marine invertebrates with their counterparts hidden in a tidepool scene. The lesson plan descriptions consist of brief overviews, intended more as a flexible starting point than a rigid list of firm instructions. The author is a former grade-school teacher with 15 years of classroom experience. (RJD) ENC-017692

Ordering Information
Frank Schaffer Publications, Inc., 23740 Hawthorne Boulevard, PO Box 2853, Torrance, CA 90509
Fax: (800) 837-7260 / Toll-free: (800) 421-5533
www.frankschaffer.com
$8.99 per activity book (paperback)

Enhanced Science Helper

Grades K-8
2000
Author: project director, Sebastian L. Foti



On this CD-ROM, an enhanced version of a product released in 1990, is an extensive library of more than one thousand hands-on science learning activities and reference materials. Advanced search capabilities allow teachers to search for lesson plans or other classroom materials by content, keyword, grade level, national standards correlations, and other criteria. The package includes digital images of materials from many sources, some of them dating as far back as the 1960s. Production of the enhanced version entailed handling more than 60,000 electronic files, scanning more than10,000 documents, and developing more than 1,000 abstracts to describe the materials. The search engine allows users to perform custom searches that return a resource list of potentially useful items. Clicking on an item instantly displays its abstract, allowing the user to determine the item's usefulness without reading the entire resource. The abstracts include details on the source of the item, its intended grade level, and an overview of the content. Another click takes the user to the resource itself. Since the resources come from different original sources, their format varies somewhat, but most include the procedure for one or more specific activities, a list of required materials, and related background information. Many of the resources include links to similar or related documents located elsewhere on the CD. In a sample activity, a unit on brine shrimp includes information on the biology of these organisms, explains how students can raise them from the cyst stage to the adult stage, and describes experiments on growth and feeding. (RJD) ENC-017581

Ordering Information
The Learning Team, 84 Business Park Drive, Suite 307, Armonk, NY 10504
Email: team10504@aol.com
(914) 273-2226 / Fax: (914) 273-2227 / Toll-free: (800) 793-8326
www.learningteam.org/
$125.00 per CD-ROM (Mac/Windows) Lab pack and District licensing also available.

Resources for Science Literacy: Professional Development

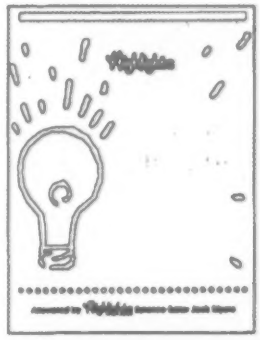
Grade K and up
1997
Author: Project 2061

The American Association for the Advancement of Science (AAAS) developed this CD-ROM and companion book to help teachers implement the goals and standards outlined in *Science for All Americans* (1989) and *Benchmarks for Science Literacy* (1993). The CD-ROM features six professional development components that include a selection of references to research, workshop activities, trade books, and course plans. Resources include the full text of *Science for All Americans* and a descriptive database of science trade books chosen to help educators refresh their knowledge of science content. An introduction to cognitive research literature addresses the ability of students of various ages to understand science concepts. Also provided are descriptions of 15 undergraduate college courses, intended as guidelines for designing syllabi that teach college students concepts from *Science for All Americans*. Additional resources include an analysis of how *Benchmarks for Science Literacy* relates to the national content standards in science, mathematics, and social studies. A Project 2061 workshop guide contains a variety of presentations, activities, and supplementary material that can be used to design a workshop or as a tutorial. The companion volume presents examples from each of the six professional development components. It also provides background information on how and why each component was developed and suggestions for its use. (Author/LCT) ENC-010990

Ordering Information
Oxford University Press, 2001 Evans Road, Cary, NC 27513
Email: custserv@oup-usa.org
(919) 677-0977 / Fax: (919) 677-1303 / Toll-free: (800) 451-7556
www.oup-usa.org
$49.95 per CD-ROM package

Book of Science Questions That Children Ask

Grades 1-6
1995
Author: Jack Myers



Selected from back issues of the *Highlights for Children* magazine for the past 30 years, this collection of answers to children's science questions covers topics in nature, the human body, and the world around us. More than 350 questions are asked and answered in this volume, which teaches students about why animals behave as they do and the reasons for some seemingly odd features of the human body. Sample questions include: Do animals cry? How many miles of blood vessels are in us? If heat rises, why is there snow on mountaintops? In sample questions about the world, students learn about how volcanoes affect the

weather, how a compass knows where to point, and why birds do not fly out into space. An index is also included. (Author/YK) ENC-017338

Ordering Information
Boyds Mills Press, 815 Church Street, Honesdale, PA 18431
Fax: (570) 253-0179 / Toll-free: (877) 512-8366
www.boydsmillspress.com
$18.95 per book (hardcover)

The Big Tree

Grades 1-8
1999
Author: Bruce Hiscock

This picture book tells the story of how a sugar maple sprouted in northern New York during the American Revolution and survived to the present day. The story describes the environmental conditions in which the seed sprouted and how the tree grew slowly until larger trees that were sheltering it from the sun fell down. Readers learn how the process of photosynthesis makes sugar that the tree uses as food or converts into cellulose. As time passes, the land on which the tree lives is converted into a farm. As loggers cut the other trees down, they count the trees' growth rings. The book explains how the root system develops and how the sap travels through the tree's vascular system. Residents are seen collecting sap from the tree and making maple syrup during the Civil War. The story explains how the tree survived damage from a heavy snowstorm and presently provides shade for the new residents of the house. The tree is existing the same way it has for over 200 years while the house has been changed by technology through the years. (Author/JR) ENC-017334

Ordering Information
Boyds Mills Press, 815 Church Street, Honesdale, PA 18431
Fax: (570) 253-0179 / Toll-free: (877) 512-8366
www.boydsmillspress.com
$7.95 per book (paperback)

Find Out Why: Presented by Disney's Timon and Pumbaa

www.findoutwhy.org
Series: Discover Magazine
Grades 2-6
2000
Author: National Science Foundation and Discover Magazine

Part of a series produced by *Discover Magazine*, this web site offers hands-on science lessons, fun activities, and resources for kids, families, and teachers. The site includes video clips in which Disney's Pumbaa and Timon present questions about the world, such as how CDs work, why the wind blows, and how pandas adapted to their environments. Additional topics covered include sneezing and reflexes, rain, flight, and the phases of the moon. For each topic, three sections of hands-on science lessons are available: for kids, grown-ups, and teachers. For example, after watching a Disney video about the phases of the moon, students keep a moon journal for a month and then look through their sketches to see changes in the moon's appearance. In the "grown-ups" section, there are resources and ideas for additional activities students can do with adults to learn more about the moon. In sample extension activities, students attend a local star party to observe heavenly bodies and explore astronomy sites on the Internet. The teacher's section contains additional hands-on science lessons, ideas for extension activities, and a description of how the activities meet *National Science Education Standards*. After students have toured the site, they are invited to test their knowledge through science games. In sample games, students mix and match different animal parts to create their own unique animal creations, control a hot air balloon to win a race, and design and print out their own custom-made full-color airplanes. Links to related web sites are also provided. (Author/YK) ENC-017881

Energy

Series: Science Trek
Grades 4-6
2000
Author: NECTAR Foundation; Learn@Gage

The six learning modules on this CD-ROM and accompanying teacher resource manual teach students about the characteristics of sound and light, electricity, simple machines, and the conservation of energy. Each CD-ROM in the Science Trek series provides multimedia learning modules that include a student tracking system, teacher background, and a student journal. The main menu on each CD-ROM provides pavilions in a Science Trek Theme Park. Inside each pavilion, there are exhibits and displays where students learn science concepts, complete experiments, and select projects. The energy pavilion contains six exhibits that allow students to explore uses of electricity, ways to measure a force, and designs for pulley systems and gear systems. They also learn about the concept of motion and its causes. In a sample exhibit on motion, students explore three types of motion (linear, rotational, and oscillating) and examine the instances in which each type occurs. In an interactive section of the display, students control a roller coaster as it moves on a track, changing the energy type as the coaster moves. One performance task challenges students to design and build a pulley system that will raise a piano up two floors to an apartment window. The program also provides a comprehensive vocabulary listing with definitions and quizzes. The teacher section of the program provides teachers with background material and many learning resources, including an overview of each exhibit content, a list of learning outcomes, and a list of Internet links related to each exhibit, in addition to a detailed bibliography of resources, sample assessment instruments, and examples of career opportunities. The tracking system in the teacher's section provides a record of students' test results and a history of their activity with the software. The teacher resource manual contains a software overview, teaching strategies, and blackline masters for performance tasks. The producer's web site address is included for users or instructors who need additional support. (Author/YK) ENC-018145

Ordering Information
NECTAR Foundation, 10 Bowhill Avenue, Nepean, Ontario K2E 6S7
Email: nectar@ecubb.on.ca
(613) 224-3881 / Fax: (613) 224-1946
www.nectar.ca
$249.00 per multi-strand CD-ROM (Windows) with resource manual
$69.00 per single-strand CD-ROM (Windows) with resource manual (contact vendor for further information)

Genetics

Series: Human Biology
Grades 6-8
1999
Author: Sean Ogren, Mary L. Kiely, H. Craig Heller

This unit, part of the Human Biology modular program, introduces genetics using everyday examples of variation and breeding. The program is an interdisciplinary, activity-based series designed to engage middle school students in using science content to help them make wise decisions. In this unit, students study human inheritance, the cellular and molecular basis of inheritance, and human genetic disorders. The teacher's guide contains an overview of the lessons, suggestions for methods, activity guides, and assessments such as homework assignments, journal writing, and embedded activities. It also contains tables that outline teaching timelines and correlate activities with key ideas. Interdisciplinary connections, enrichment activities, and reproducible student activity pages are provided. The student book contains background information and questions to help students review, evaluate, and apply the chapter concepts. Topics addressed in this unit include genetic continuity within biodiversity, replication and expression of DNA, and the principles of inheritance. To help them make informed political decisions, students learn about current issues, such as genetic engineering and the Human Genome Project. In one chapter, students learn the location and number of chromosomes in human cells. They use karyotypes to discover the characteristics of chromosomes and explain how they can be used to detect genetic disorders. The students can investigate and evaluate the Human Genome Project as a long-term activity. Internet addresses are provided in the teacher's guide. (Author/JR) ENC-016084

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(312) 540-8210 / Fax: (312) 540-5048 / Toll-free: (800) 382-7670
www.everydaylearning.com
$25.00 per teacher's guide (paperback)
$8.50 per student text (paperback). Contact vendor for quantity discounts.
$212.50 per classroom set (includes 25 single-title student texts and 1 teacher's guide)

Investigating Systems and Change

Series: BSCS Middle School Science and Technology
Grades 6-8
1999
Author: Biological Sciences Curriculum Study (BSCS)

In this kit, the third level of study in the Biological Sciences Curriculum Study (BSCS) Middle School Science and Technology series, are units that allow students to examine systems from physiological, evolutionary, and technological perspectives. The last section of the study uses a science, technology, and society (STS) approach to tie the previous concepts together with the concept of limits to population growth. The goals of the series are to develop middle school students' understanding of basic concepts and skills related to science and technology, increase the participation of underrepresented students, and promote all students' development of critical thinking and problem-solving abilities. This kit comprises a student book, a teacher's edition, and a teacher's resource book. The student book has readings, investigations, and connections sections with activities that follow the module's unifying theme. The teacher's edition contains reduced images of the student pages that are surrounded by sections to assist the teachers in their preparation and facilitation of the lessons. Each activity includes support material such as the indicators of success, assessment suggestions, and materials lists. The teacher's resource book has information about the implementation of the program, ideas for extension activities, and blackline masters. It also provides research information about education topics, such as learning styles and assessment, in addition to a table that correlates the parts of the program with the National Science Education Standards. In this level of study, students learn about systems in and out of balance, systems in evolutionary change, and energy use in technological systems. In a sample activity, students explore energy in a variety of systems, such as a battery-powered appliance or a goldfish. Four characters are used throughout the book to provide a concrete method for demonstrating the different learning styles, to teach some history of science, and to provide positive cooperative learning role models. (Author/JR) ENC-018823

Ordering Information
Kendall/Hunt Publishing Company, 4050 Westmark Drive, PO Box 1840, Dubuque, IA 52004
Fax: (800) 772-9165 / Toll-free: (800) 228-0810
www.kendallhunt.com
$48.99 per student edition (hardcover)
$99.99 per teacher's edition (spiral-bound)
$99.99 per teacher's resource book (spiral-bound)

The Real Reasons for Seasons, Grades 6-8: Sun-Earth Connections

Series: GEMS
Grades 6-8
2000
Author: Alan Gould, Carolyn Willard, Stephen Pompea

Part of the GEMS series, this teacher's guide and supplementary CD-ROM contain activities in which students investigate what causes our planet's seasons. GEMS is an ongoing curriculum project to develop guided discovery activities with instructions and background information for teachers without formal training in math or science. The purpose of this unit is to help students overcome persistent misconceptions about the causes of the seasons. The accompanying CD-ROM contains supporting resources, including images, video clips, web links, and two software packages: Seasons and Starry Night. In the Seasons simulation program, students can change the tilt of the Earth's axis and the Earth's orbit to explore the causes of seasons. The Starry Night program is a planetarium program that allows students to determine where the sun, moon, and stars are at any date. The guide contains eight activities that challenge students' common misconceptions. In sample activities, students graph and analyze number of hours of daylight from cities around the world, and create a model of the sun-Earth system to learn about how the tilt of the Earth's spin axis causes seasons. The guide also discusses the seasons and misconceptions in teaching science. Each activity includes a list of discussion questions and suggestions for extensions. Additional information includes summary out-

lines of each activity, background information, and ideas for further investigation, as well as connections to children's literature, assessment suggestions, and blackline activity masters. (Author/YK) ENC-018933

Ordering Information
GEMS, University of California, Berkeley, Lawrence Hall of Science #5200, Berkeley, CA 94720
(510) 642-7771 / Fax: (510) 642-8307
www.lhs.berkeley.edu
$25.50 per teacher's guide (softcover) with CD-ROM (Mac/Windows)

Properties of Matter

Series: Science and Technology Concepts for Middle Schools
Grades: 6-9
2000
Author: developer/writer, David Marsh

The Science and Technology Concepts for Middle Schools (STC/MS) curriculum program is designed to fully address the *National Science Education Standards* and to appeal to the interests of students from diverse cultural backgrounds.This module is introduced through a series of short inquiries that include cooperative learning groups, brainstorming, and classroom discussions. The teacher's guide provides strategies for planning and conducting the lessons, along with suggestions for preparation, extensions, and assessment. The student book features lessons that cover mixtures, compounds, and chemical reactions. There are suggestions to the teacher regarding safety, with a reproducible safety contract letter for the students and their parents. In one lesson, students construct simple thermometers and use them to investigate the effect of heat on the density of air and water. In another lesson, students investigate phase change by graphing the temperature changes encountered when ice water is heated to its boiling point. Throughout the course of the module, students work on an Anchor Activity in which they investigate the relationship between characteristic properties of substances and their uses in manufacturing. Students conclude the module by giving an oral presentation. The module comes with a bibliography and two appendixes: one listing the student sheets distributed during the course, the other explaining the alignment with the *National Science Education Standards* and the fundamental concepts and principles addressed by the module. (Author/FCM) ENC-017924

Ordering Information
Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215
Email: carolina@carolina.com
Fax: (800) 222-7112 / Toll-free: (800) 334-5551
www.carolina.com
$99.95 per teacher's guide (loose-leaf binder)
$54.95 per 4-pack of student guide and source book (paperback)

The New Book of Popular Science

Grades: 6-12
2000
Author: Grolier

This set of six volumes is intended as a complete guide to science and technology. Formatted in an encyclopedic style, each book features detailed descriptions of scientific phenomena, the history of their discovery, and their applied uses. The material is arranged by topic, with each volume specializing in a particular discipline or a small number of related disciplines. Disciplines discussed include the basic principles of biology, chemistry, and physics as well as more specific information on plant life, animal life, and human science. Also discussed are Earth sciences, energy, and environmental science. Additional disciplines include astronomy, space science and mathematics, as well as technology, with special emphasis on computers. The set includes contributions from hundreds of authors and reviewers, with sidebars on careers in the sciences and emerging technologies as well as biographies of famous scientists. Every volume contains a full index of material found in the entire set and a selected reading list. In addition, volume six includes several appendices, such as physical constants, measurement conversion tables and a list of Nobel Prize winners. (RJD) ENC-017495

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$249.00 per six-volume set. Discounts available for bulk orders. Contact vendor for further information.

CORD Biology: Science in Context

Series: Center for Occupational Research and Development
Grades: 9-12
1997
Author: developed by the Center for Occupational Research and Development
Publisher: South-Western Educational Publishing and Globe Fearon, Inc.

This curriculum kit presents biological concepts in the context of careers and real-world problems. The kit is composed of a text and support materials that include a laboratory manual, an assessment package, and a videotape that can be used to introduce each of the units. Teaching tips and materials are provided in a teacher's resource book and a teacher edition of the text. The kit emphasizes the role that contextual and cooperative learning have in facilitating students' efforts to connect new concepts to existing knowledge and to the world outside the classroom. The text begins each chapter with a two-page spread that explains why the students should learn the material, lists learning objectives, and offers a specific example of what is covered in the chapter. Readers can find interviews with people who have careers related to the topics in the chapter. The text highlights changes in scientific thought to illustrate that biology is not static. Scientific terms are defined in margin notes. Hands-on activities, designed to be done in small groups, require the students to use process skills such as observation, measurement, and classification. The lab manual has investigations that involve procedures or modifications of procedures used by scientists and technologists in a variety of fields. The teacher's resource book contains objectives, assessment rubrics and masters, and information to prepare the activities and investigations as well as blackline masters and chapter notes. (Author/ JR) ENC-018934

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$14.95 per laboratory manual (softcover)
$149.95 per user's manual and test generator text (softcover) with CD-ROM (Mac/Windows)

Evolution

Grade: 11 and up
2000
Author: Vanessa W. Strickberger

In this textbook, the process of evolution is used as the basis for biological phenomena. The author covers the topics of evolutionary biology from a historical perspective and provides thorough background knowledge for upper secondary science

students as well as their teachers. The book begins by examining the earliest ideas about evolution that led up to Darwin's theory of natural selection. Darwin himself is examined along with his impact on social and religious views. The earliest processes of evolution are covered, from the origin of the universe, through the geological changes that occur on Earth, to the chemical evolution of organic molecules and first life.The genetic basis of evolution is outlined, and the relationship of evolution to systematics and classification is explored. Multiple chapters are devoted to exploring the evolution of various groups of living organisms including plants and fungi, bacteria and invertebrates. Vertebrate evolution is followed from fish through humans. How the process of evolution proceeds is the final topic in the book. Population genetics, neutral theory, and behavioral patterns are some of the ideas explained in this section. Each chapter provides a list of key terms and discussion questions as well as a list of references. The publisher maintains a web site with links and web exercises for each chapter. (Author/SSD) ENC-018491

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Jones and Bartlett Publishers, 40 Tall Pine Drive, Sudbury, MA 01776
(978) 443-5000 / Fax: (978) 443-8000
www.jbpub.com
$74.95 per book (hardcover)

Background Reading

200 Percent of Nothing: An Eye-Opening Tour Through the Twists and Turns of Math Abuse and Innumeracy

Grade 7 and up
1993
Author: A. K. Dewdney

This book provides insight into the everyday abuses that arise from a lack of mathematical thinking. It consists of a series of examples outlining abuses in arithmetic, algebra, and statistics that manifest themselves in, for example, false advertising, financial scams, and misleading political claims. (Author/MM) ENC-018188

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John Wiley and Sons, Inc., One Wiley Drive, Somerset, NJ 08875
(908) 469-4400 / Fax: (732) 302-2300 / Toll-free: (800) 225-5945
www.wiley.com
$22.95 per book (hardcover)

Action, Talk and Text: Learning and Teaching Through Inquiry

Series: *Practitioner Inquiry*
Grades K-12
2001
Author: editor, Gordon Wells

Written by elementary, intermediate, and secondary teachers, this collection of essays describes classroom experiences that demonstrate components of inquiry-based learning. Chapters focus on ways that students construct meaning, the value of class discussions, and how to foster knowledge building. (Author/JG) ENC-018875

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Teachers College Press, Columbia University, PO Box 20, Williston, VT 05495
Email: tcp.orders@aidcvt.com
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www.teacherscollegepress.com
$24.95 per book (softcover)

Cancer

Series: *Contemporary Issues Companion*
Grades 6-12
2000
Author: editor, Lisa Yount

The essays in this book provide personal accounts of dealing with a diagnosis of cancer. The book offers different perspectives on the future outlook for cancer research and treatment. (Author/YK) ENC-018842

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Lucent Books/Greenhaven Press, PO Box 289011, San Diego, CA 92198
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www.lucentbooks.com
School price $14.96 per book

Catch Them Thinking in Science: A Handbook of Classroom Strategies

Grades 5-12
1993
Author: Sally Berman

This book contains classroom-tested techniques for the transformation of traditional science topics into exercises that engage students' minds. The book is based on a three-story intellect model that focuses on collecting facts and thoughts, processing information in a variety of ways, and critically analyzing and creatively applying information. (Author/JR) ENC-017855

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www.skylightedu.com
$26.95 per handbook

Children's Participation: The Theory and Practice of Involving Young Citizens in Community Development and Environmental Care

Grades K-9
1999
Author: Roger A. Hart
Publisher: Earthscan Publications Ltd. and UNICEF

UNICEF developed this book as an introduction to children's participation and the effectiveness of their participation in community-based environmental planning and management. It also offers organizing principles and methods for involving children in community development and environmental projects. (Author/SSD) ENC-018859

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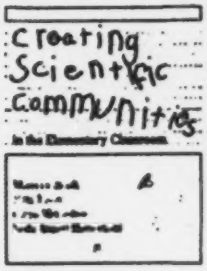
Creating Scientific Communities in the Elementary Classroom

Grades K-6
1998
Author: Maureen Reddy, Patsy Jacobs, Caryn McCrohon, Leslie Ruppert Hovrenchuk



This book describes the results of a five-year ethnographic study of the development of early scientific literacy in an elementary school classroom. In the study, elementary school teachers and academic researchers collaborated to develop classroom environments in which students acquired the values and attitudes associated with successful scientific collaboration. (Author/LCT) ENC-012613

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www.heinemann.com
$24.00 per book

Developing Biological Literacy: A Guide to Developing Secondary and Post-Secondary Biology Curricula

Series: Biological Sciences Curriculum Study
Grade 9 and up
1995
Author: Biological Sciences Curriculum Study

This guide offers three major recommendations for designing contemporary biology curricula at the secondary and post secondary levels: the content of biology must be unified by the theory of evolution; biology classes must provide opportunities for students to experience science as a process and to understand science as a way of knowing; and programs should help students develop biological literacy. (Author/LCT) ENC-014846

Ordering Information
Kendall/Hunt Publishing Company, 4050 Westmark Drive, PO Box 1840, Dubuque, IA 52004
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www.kendallhunt.com
$19.95 per book (paperback)

High School Mathematics at Work: Essays and Examples for the Education of All Students

Grades 9-12
1998
Author: National Research Council

These essays examine how high school mathematics can and should help students deal with situations they encounter in their everyday lives. Each of the book's four sections concludes with examples of tasks and projects taken from everyday contexts. (Author/RMK) ENC-012661

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National Academy Press, Lockbox 285, 2101 Constitution Avenue NW, Washington, DC 20055
(202) 334-3313 / Fax: (202) 334-2451 / Toll-free: (888) 624-8373
www.nap.edu
$27.95 per book (paperback)

Math and Science for Young Children

Grades preK-3
1999
Author: Rosalind Charlesworth, Karen K. Lind

In this book the authors present an organized, sequential approach to creating developmentally appropriate math and science curricula aligned with national standards. Emphasis is placed on three types of learning: naturalistic, informal, and structured. (Author/SSD) ENC-018381

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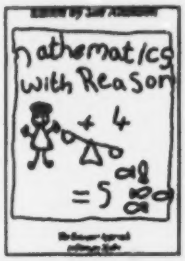
$61.95 per book

Mathematics With Reason: The Emergent Approach to Primary Maths

Grades preK-6
1992
Author: editor, Sue Atkinson



Written to support the 1989 NCTM standards, this book explores ways of making mathematics teaching more effective both at home and at school. The ideas in the text come from teaching and advisory work, from research, and from discussions with groups of teachers and parents. (Author/KFR) ENC-007763

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Nature's Numbers: The Unreal Reality of Mathematics

Series: Science Masters
Grade 10 and up
1995
Author: Ian Stewart

In this book is an explanation of how mathematicians view the world and how mathematics influences the world. Chapters demonstrate the mathematical ideas in physics, music, chaos, and biology. (Author/MM) ENC-018899

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Perseus Books Group Basic Books, Inc., c/o Westview Press, 5500 Central Avenue, Boulder, CO 80301
(212) 207-7057 / Fax: (303) 449-3365 / Toll-free: (800) 386-5656
www.perseusbooks.com
$12.00 per book (paperback)

Numeracy and Beyond: Applying Mathematics in the Primary School

Grades 1-5
2000
Author: Martin Hughes, Charles Desforges, Christine Mitchell with Clive Carre

This book presents findings of a study in which British primary teachers worked with a research team to develop their understanding of the nature of knowledge acquisition and to explore how this knowledge influenced their teaching practice. (Author/JRS) ENC-018378

Ordering Information
Open University Press/Taylor & Francis, 325 Chestnut Street, Philadelphia, PA 19106
www.openup.co.uk
$24.95 per book (paperback)

Problems of Meaning in Science Curriculum

Series: Ways of Knowing in Science
Grades 8-12
1998
Author: editors, Douglas A. Roberts, Leif Ostman

These 13 essays examine the selection, production, and expression of meaning offered to students by the school science curriculum. Examples for analysis are drawn from sources that include policy debate, textbooks, and the 1995 National Science Education Standards. (Author/LCT) ENC-013019

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www.teacherscollegepress.com
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Science for All Americans

Grades 8-12
1990
Author: F. James Rutherford, Andrew Ahlgren

This book consists of a set of recommendations on what understandings and ways of thinking are essential for scientific literacy. The majority of the book discusses the content to be learned, while the remaining chapters cover teaching, reform, and future actions. (Author/JG) ENC-018805

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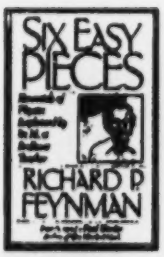
Oxford University Press, 2001 Evans Road, Cary, NC 27513
Email: custserv@oup-usa.org
(919) 677-0977 / Fax: (919) 677-1303 / Toll-free: (800) 451-7556
www.oup-usa.org
$15.95 per book (paperback)

Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher

Grade 9 and up
1995
Author: Richard P. Feynman



The general reader is introduced to fundamental aspects of physics, examining such topics as atoms, basic physics, and the relationship of physics to other topics, in addition to energy, gravitation, and quantum force. A short biography of Feynman and an index are also included. (Author/YK) ENC-017925

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www.perseusbooks.com
$13.00 per book (paperback) Also available on audiocassette tape and CD.

Strength in Numbers: Discovering the Joy and Power of Mathematics in Everyday Life

Grade 9 and up
1996
Author: Sherman K. Stein

Written in a conversational style, this book uses short historical excursions to introduce the discoveries and beauty of mathematics. The book seeks to impart an understanding of the language of mathematics, a clearer idea of its importance, and an appreciation of mathematical reasoning. (Author/JAR) ENC-016499

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John Wiley and Sons, Inc., One Wiley Drive, Somerset, NJ 08875
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www.wiley.com
$14.95 per book (paperback)

Teaching and Learning Science: Towards a Personalized Approach

Grades 1-12
1998
Author: Derek Hodson

This book is intended to critique, extend, and unify recent debate and research about science education in several disparate fields, including philosophy of science, cognitive psychology, and motivation theory. Topics discussed include the definition and value of scientific literacy and the theory-laden nature of scientific terms. (Author/RJD) ENC-017339

Ordering Information
Open University Press / Taylor & Francis, 325 Chestnut Street, Philadelphia, PA 19106
www.openup.co.uk
$29.95 per book (paperback)

Through Mathematical Eyes: Exploring Relationships in Math and Science

Series: Moving Middle Schools
Grades 6-8
1997
Author: editor, Ron Hachkart

This book presents vivid, revealing stories of how teaching the concept of functions can play out in diverse middle school classrooms ranging from those in rural Maine to those in urban San Francisco. The goal is for other teachers to read and reflect and then adapt, implement, and revise what they learn to help their students engage in real-world mathematics. (JRS) ENC-011369

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$19.50 per book

Tools for Understanding: A Resource Guide for Extending Mathematical Understanding in Secondary Schools

www.ups.edu/community/tofu
Grades 7-12
1999
Author: project directors, John Woodward, Juliet Baxter
Publisher: University of Puget Sound

This web site is divided into three strands of information and activities: math concepts with topical lessons related to prealgebra concepts and statistics; integrated lessons with three examples of business-related, open-ended problems; and teacher strategies for introducing journaling as a way for students to explain and expand their mathematical thinking. (Author/JRS) ENC-016331

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